Concrete

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Concrete Control Methods

Employed in Constructing a

Six-Million Gallon Water Reservoir*

A Description of the Methods Used to Control the Quality of the Concrete Used in Building a Reservoir for the Indianapolis Water Company — Test Results — Water Regulation—Proportions—Placing Methods—Inspection —Contractor's Plant

By W. C. MABEE

A PRACTICAL example of the application of the newer and more accurate methods of field control of concrete is found in the construction of an important water works structure for the Indianapolis Water Company at Indianapolis. So far as is known, this was only the second job to be completed in Indianapolis under water-cement ratio specifications. The methods applied resulted in concrete that easily met the requirements and they worked no hardship on the contractor.

The reservoir was constructed in 1926 at the Fall Creek Station of the Indianapolis Water Company by the local organization of the Thompson-Binger Co. of New York, General Contractors. It occupies a space approximately 270 feet square and has a gross area of over 60,000 square feet, with an overall depth of 16 feet, and a storage capacity of 6 million gallons.

The roof is a flat slab, 8 inches thick supported by circular columns 20 inches diameter spaced 16 feet centers and resting upon a groined-arch floor having a minimum thickness of 8 inches.

Local ground water conditions made necessary the provision that the structure and its loading should have weight sufficient to balance an upward pressure of ground water at flood times with the reservoir nearly empty,—hence the groined arch floor design. Incidentally, the arched floor forms valleys which permit easy cleaning.

Quantity and Quality of Concrete

The reservoir contains over 5,000 cubic yards of concrete of two grades. The floor and wall concrete was made with a water-cement ratio by volume of .8 or 6 gallons of water per cubic foot of cement and the flat slab .83 or 6¼ gallons as near as it could be determined within practical limits, aiming at a 28-day strength not less than 2500 pounds per square inch in compression, and a water-tight concrete throughout.

Two 6-inch diameter cylinders each 12 inches long were made each day from the same batch taken after it was deposited in the forms and tested as follows:

$$6 \text{ Gal. Mix } \frac{W}{C} = .8$$

No. of Tests	7 Days Avg.	No. of Tests	28 Days Avg.
31	2,180	24	3,520
	Lbs. Sq. In.		Lbs. Sq. In.
Maximum	3,240		4,690
Minimum	1,480		2,430

$$6\tfrac{1}{4} \text{ Gal. Mix } \frac{W}{C} = .83$$

No. of Tests	7 Days Avg.	No. of Tests	28 Days Avg.
10	1,830	10	3,200
	Lbs. Sq. In.		Lbs. Sq. In.
Maximum	2,510		4,350
Minimum	910		2,250

Grouping these results and comparing them with Abrams' curve, the 6-gallon mix yielded an average strength at 28 days of 3,570 pounds per square inch for 45 samples broken, after making allowance for increase in 28-day strength over 7-day strength, corresponding to 3000 on Abrams' Curve "A." The 6¼-gallon mix indicated a somewhat similar result. These results were gratifying and were made possible by:

1st: Care in the selection of aggregates and in the combination of sand and gravel.

2nd: Selection of the water-cement ratio and the design of the mix that would make a workable concrete.

3rd: Reasonably careful measurements of aggregates as delivered to the mixer.

4th: Actual measurement of the water added to each batch after making an allowance for moisture in sand and gravel.

5th: Control of the time of mixing by the use of a time lock on the mixer.

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*Abstract of a paper read before the Indiana Section of the American Water Works Association.

6th: Distribution of the concrete to its position in the work without segregation of materials.

7th: Agitation or puddling in forms, particularly in narrow walls or columns, and

8th: Curing the concrete under wet or moist conditions.

These are the important steps in the field control of concrete which if given reasonable care and attention promote better uniformity in concrete construction.

Departure from Usual Practice

The letting of a contract in Indianapolis for concrete proportioned by the water-cement ratio was so far as the writer has knowledge the second instance of this kind. In order, therefore, to eliminate the uncertainty of the contractor as to the amount of cement that would be required, and to enable all bids to be made on a comparable basis, the company fixed the quantity at 1½ barrels per cubic yard of concrete, with a provision in the contract for compensation if more than this amount were used and a saving to the company if less cement was used.

Trowelled Surface Specified

The quantity actually used amounted to 1.535 barrels per cubic yard, or 2 1/3 per cent in excess of the amount estimated. This included cement used in top finish dusting, where a trowelled surface was specified. This provision in the contract removed the incentive to skimp the work on the part of the contractor and was a satisfactory arrangement for the owner.

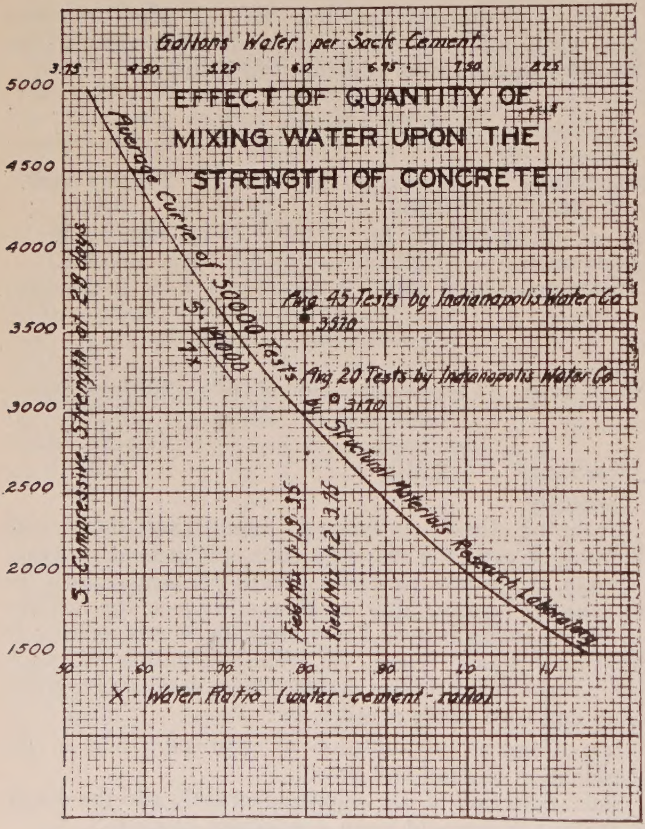


Chart showing effect of quantity of mixing water on the strength of concrete

The specification provided that the strength of test specimens at 28 days should be 2500 pounds per square inch. Twenty-four cylinders tested at 28 days taken from concrete mixed with a water-cement ratio of .80 developed the following strength:

	Cylinder
Less than 2500 lbs. per sq. in.	1
2500 to 3000 lbs. per sq. in.	7
3000 to 3500 lbs. per sq. in.	5
3500 to 4000 lbs. per sq. in.	5
4000 to 4500 lbs. per sq. in.	5
Over 4500 lbs. per sq. in.	1

Average: 3520 for the 24 cylinders

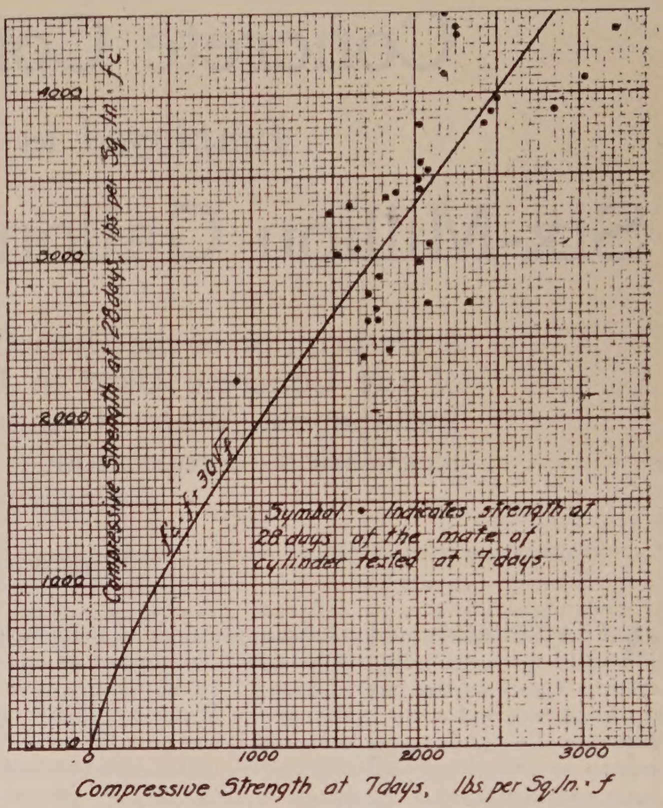


Chart showing relation of 7- and 28-day strengths

The average shown in the chart as 3570 was arrived at by combining the probable strength at 28 days of those specimens tested at 7 days with the 28-day tests (see chart).

Combining Aggregates

The first step in the design of the field mix after assuming the water-cement ratio of .80 or 6 gallons of water to the sack of cement was to determine the ratio of fine to coarse aggregates; this was done in the manner prescribed by the Portland Cement Association Manual and involved screening, drying and weighing.

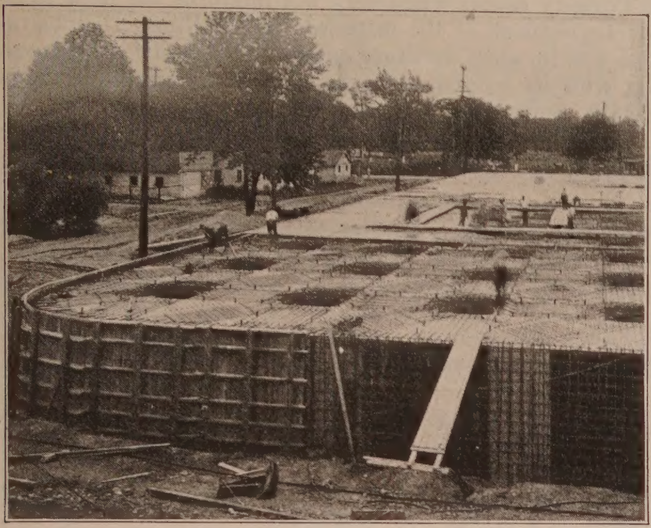
The sand and gravel obtained locally was washed and screened and proved satisfactory in every way. It was combined with a fineness modulus of 5.6.

While the field mix was calculated approximately 1:1.9:3.5, it is probable that the actual mix was nearer 1:1.7:3.4 as reflected in the quantities of aggregates actually purchased. The sand and gravel was stored in separate bins and discharged into a measuring hopper divided into two sections, which were marked off by trial to hold their respective quantities.

Numerous tests for moisture in the sand yielded results ranging from 3.7 per cent by weight measured loose to 12½ per cent with an average of 7 per cent. The coarse aggregate indicated about 3 per cent.

Quality Control

Six gallons of water to the sack of cement was the maximum water allowed. Because of the wide variation of moisture in the sand the quantity of water added to each batch was usually determined from the higher percentages found, so that in all probability the water-cement ratio was somewhat less than .80. A tank calibrated to a scale graduated to gallons was used to measure the additional make-up water and care was exercised in filling this tank to the required level.


Construction view showing forms and reinforcement

If it were found necessary to increase the workability of the concrete, this was done by reducing the quantity of aggregates, usually the coarse aggregate, and allowing the water-cement ratio to remain constant. Four sacks of cement were used in a batch and from 16 to 18 gallons of water added. Each batch contained two-thirds of a cubic yard of concrete.

Increasing the time of mixing produces a somewhat stronger, more workable, more homogeneous and consequently a more nearly water-tight concrete.

The time of mixing was one and one-half minutes which is a half minute longer than the usual allowance and was accomplished by means of a time-lock on the mixer. The discharging lever could not be operated until a gong sounded announcing that the time interval had elapsed. The 1½ minute is measured after all materials are in the mixer and until the batch is discharged.

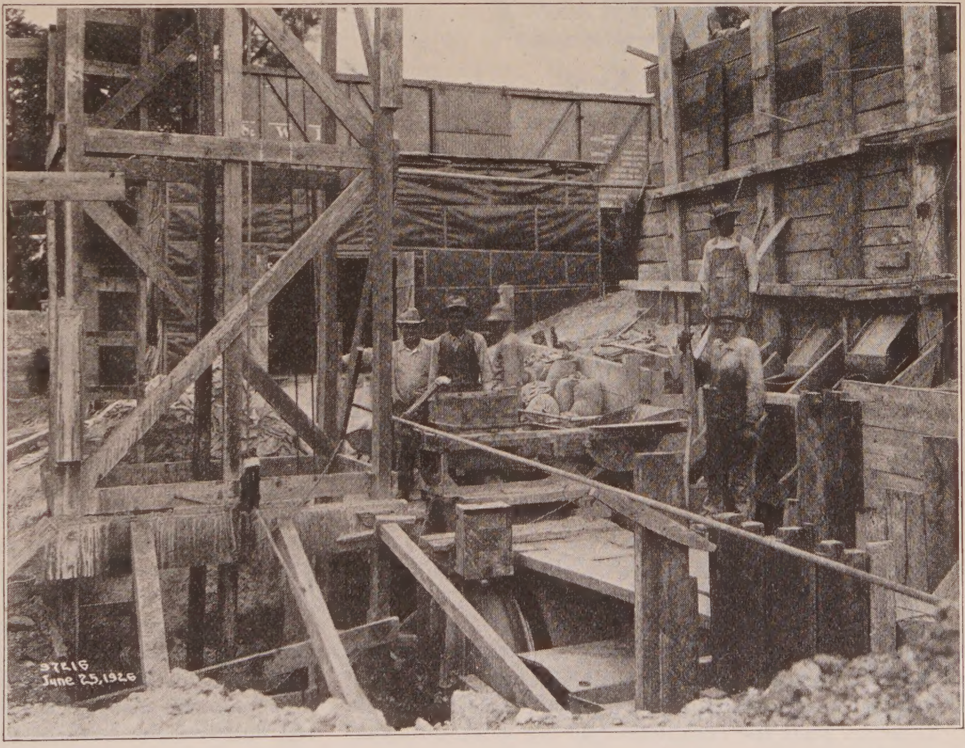
This scheme worked to the advantage of the contractor and owner alike.

At least two slump tests were made daily and varied from 1 to 8 inches, usually about 3 inches in the floor concrete and about 6 inches in the flat slab and 7 inches in the walls; they were made in the regular way. The slump test is a useful index to workability and indicates whether the concrete is too stiff or too wet. Visual observation of uniformity is not sufficiently reliable, however experienced the observer may be.

Placing Concrete

A short tower and hoist was used to raise the concrete from the mixer in a pit to an elevation that would permit it to fall into a hopper from which point it was discharged into concrete carts and wheeled to position without segregation.

Reservoir concrete is intended to prevent the percolation of water and it was essential that the mass be puddled quite thoroughly to prevent honeycombing and to present a smooth surface upon the removal of forms. The floor was dusted with a mixture of sand and cement and trowelled smooth while the concrete was still plastic. Absolutely tight forms are not essential as excess water that escapes through forms reduces water-cement ratio and increases strength.



Proportioning the material. An Ahlers strength regulator was used to control the water content

Curing

It has been found by experiment that concrete moist-cured will develop from 1½ to 3 times the 28-day strength of dry-cured concrete. Concrete is kept wet not to permit moisture to enter but to prevent the moisture that is already there from escaping until the chemical reactions have been completed.

The floor was covered with burlap and kept wet for 7 days. The roof was flooded by means of mortar dams built about the margins of each day's work and an effort made to keep it flooded for a week. No practical way was found for keeping the walls moist except that the forms were allowed to remain for a longer period than would otherwise have been necessary.

Local conditions were in favor of a simple plant layout as illustrated in an accompanying sketch. Cement was brought in on the station coal trestle, chuted down into the cement house and wheeled a very short distance to the mixer.

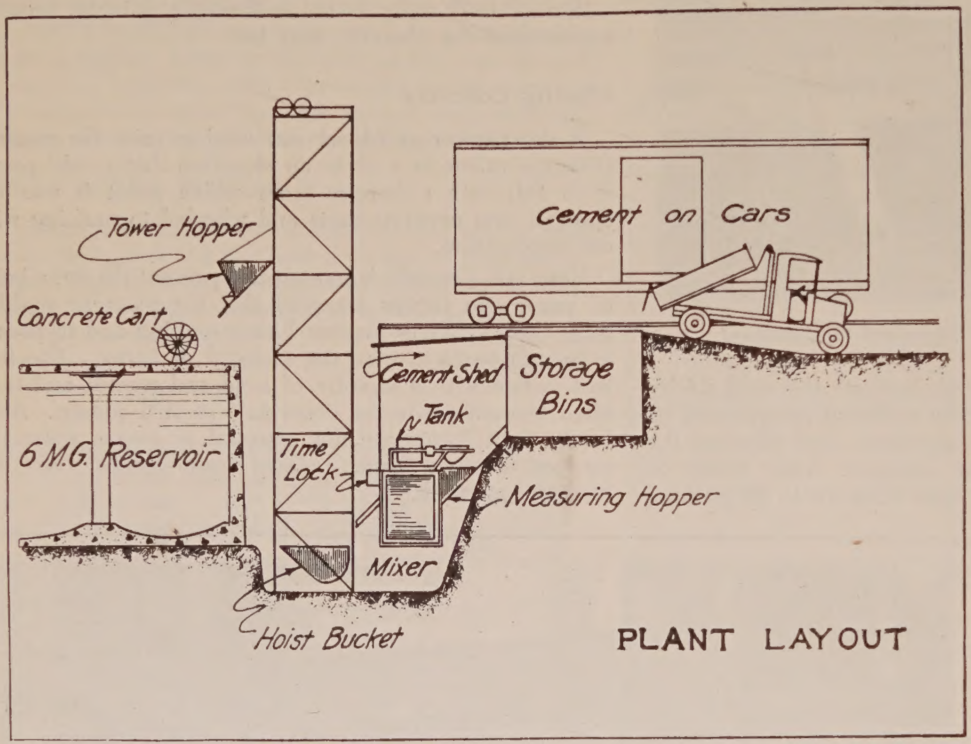


Diagram showing arrangement of contractor's plant

By placing the mixer in a pit just outside the structure it was possible to chute sand and gravel from the unloading bins directly into the measuring hopper over the mixer,—the short tower and hoisting engine did the rest. Concrete carts were used for transporting concrete.

Ten weeks were required to complete the work, the average rate of placing being 500 cubic yards per week elapsed time. After the first two weeks the contractor struck his stride and the rate of progress from then on was fairly uniform.

Inspection of Work

A resident engineer was placed in charge of this work and he was given an assistant engineer; both acted as inspectors, gave lines and grades, made test cylinders, slump tests, sieve analyses, moisture determinations and reported daily progress and quantities involved.

A leakage test extending over a period of 24 hours made several weeks after the completion of the work indicated a loss of 21,000 gallons or about 3/10 of 1 per cent, excluding evaporation. The depth of water at test was 14 feet.

In structures designed to withstand exposure to water and weather, the strength factor is secondary to density; concrete that will flow in chutes is too wet for this character of work unless the aggregate is reduced while maintaining the same water-cement ratio. Good materials otherwise suitable may be spoiled by too much water. Durability can only be obtained by subordinating strength and economy. A concrete amply strong for the required loadings may be of such a porous nature that it will not withstand the elements and will in a few years show signs of disintegration.

Porosity occurs when very wet mixtures are used causing segregation of the materials in handling. Disintegration sets in when moisture enters and is assisted by freezing with its consequent expansion and disruption. This usually begins at the water line but may occur at day joints improperly made, permitting water to percolate through the structure, giving opportunity for saturation and subsequent freezing.

The requirements for durable concrete are clean aggregates, a fairly rich mixture, placing without segregation and proper curing.

Short Cuts in Water Control

In the general run of building operations in Indianapolis the sand is brought to the site of the work where there is small storage space, consequently there is slight opportunity for the moisture to escape and in the absence of scientific water control, a good practice is to deduct one gallon of water from the quantity required under the assumed water-cement ratio for each cubic foot of sand that goes into the batch.

This allowance compensates for about 9 per cent of moisture in the aggregates.

I heard of an instance where a conscientious contractor had installed an overflow pipe from the water tank which led out over the head of the operator and when the tank overflowed the water fell on the man; of course it didn't overflow very often.

Acknowledgment is made for the co-operation and assistance of Carl Geupel, the local representative of the Thompson-Binger Co. and to Mr. B. J. T. Jeup, Chief Engineer of the Indianapolis Water Company, and to the local representatives of the Portland Cement Association.

Some Notes on Products Plant Design

Distances of Moving Materials in Plant Affect Cost of Product—Plant Can Be Too Large for Economical Operation—Design of Curing Rooms

AMONG the interesting features in products plant design that were incorporated in the new plant of the Cement Products Company at Davenport, Iowa, was a careful consideration of the distances which materials and products were moved in their travel from the material bins to the yard.

Austin Crabbs, who designed and built the plant, has made a thorough study of this subject and has arrived at the conclusion that there is a point in production capacity beyond which it is more economical to build a new plant than to enlarge an existing plant. Beyond this point the cost of manufacturing increases to such an extent that another plant would reduce production costs. He believes that a plant making 5,000 block per day has reached the limit for economical production.

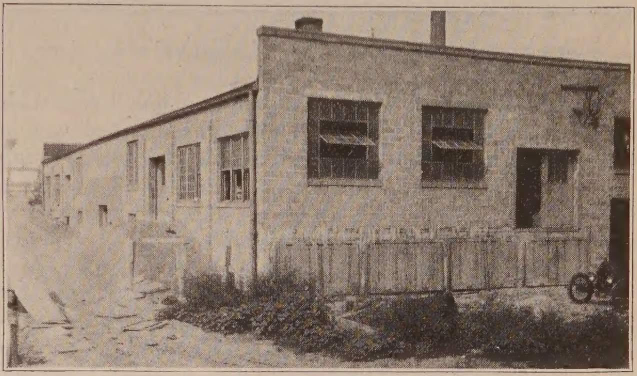
Handling Materials

In the average plant materials and finished products are moved unnecessarily great distances. Each additional foot of distance adds to production costs. Usually plants can be designed to effect greater economy in this regard.

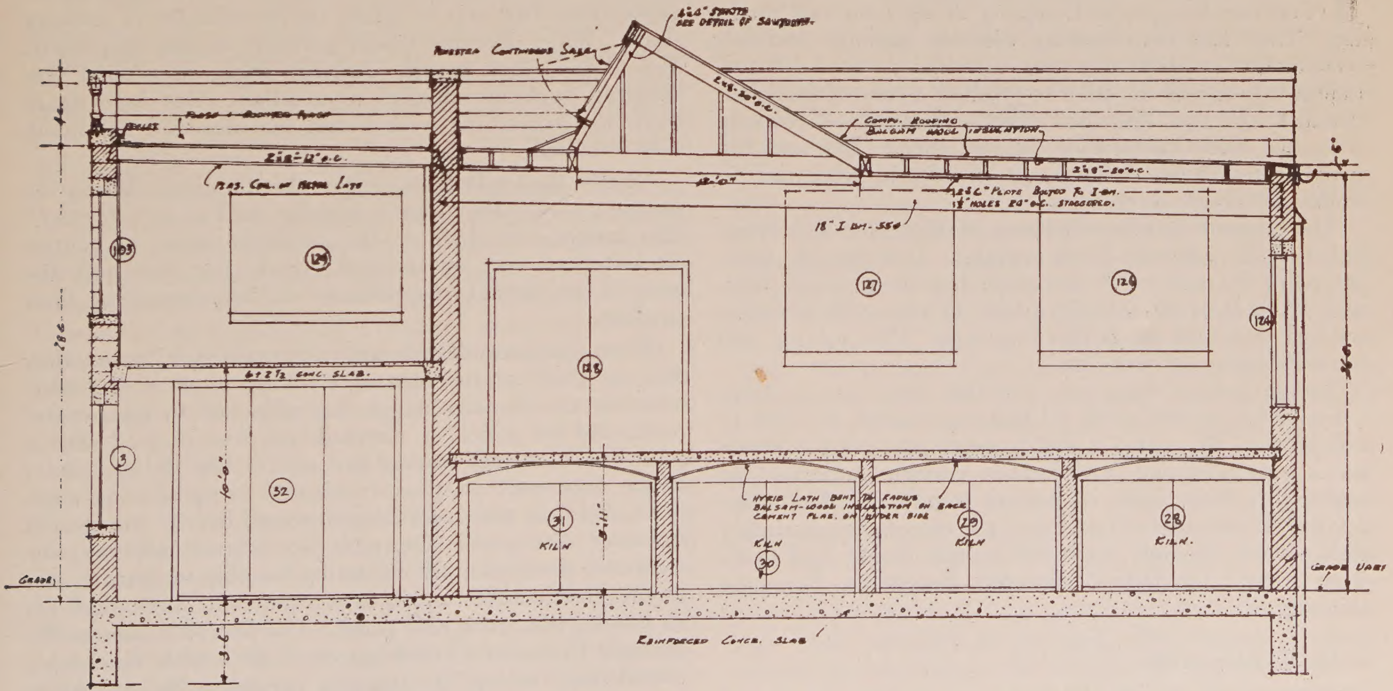
The result of efforts to cut down haulage distances in the plant of the Cement Products Company at Davenport was a design in which the materials are delivered in the center of the building. The shop is then laid out in two complete units, each working from the center to one end of the plant.

The block machines were set up in two units at the center of the plant near the material supply. One unit faced the curing rooms on the west end of the building, the other those on the east end. With this arrangement, the total distance that the materials and finished products are moved was cut in half. When the plant operates at half capacity, only one of the units is in service. When the demand increases, the other unit is put into service. The block moves from the machines through the curing rooms into yard storage in a straight line over the shortest possible distance.

Also the weight of the block itself has been cut down. Block of the 8x8x16-inch size have more than 55 per cent air space and weigh only 42 pounds as against the average weight of 52 pounds—a saving in materials and in handling costs. This has been accomplished partly by deepening the hand mold, which is an improvement also very much appreciated by the masons who place the block in the wall.



The outside doors of the curing rooms show the location of the curing rooms in the building



A cross section of one end of the plant, showing the design of the curing rooms

Curing Rooms

The design of the curing rooms at the plant also follows definite lines resulting from a study of curing room performance. They are located at each end of the plant, as previously described. Each chamber is about 8 feet wide by 5 feet high with a slightly arched roof, as shown in an accompanying illustration of a cross section through the curing room end of the building.

Aggregates are received by boat and unloaded at the dock

The floor of the curing room is, of course, level with the floor of the rest of the plant. Above the curing rooms is another reinforced concrete floor which serves as the trim stone department.

The curing rooms are entirely housed in the building. This, according to Mr. Crabbs, is an important item because the temperature in the steam rooms must be kept as nearly constant as possible for the best results, regardless of outdoor weather conditions. By placing the curing rooms inside the building this requirement is met more fully than if the curing rooms are outside because the temperature inside the building is maintained more nearly uniform. The building acts as insulation for the kilns. Space is not sacrificed by this arrangement because the floor above the curing rooms can be used for manufacturing trim stone or other specialties.

Another factor of importance in curing room construction is the design of the doors. They must open easily; they must close tightly, especially at the top and sides, and they must not warp or shrink. The Cement Products Company has used tin-clad doors opening upward, with excellent results.

Marketing a Concrete Products Specialty

Methods Necessary to Success in Finding a Market for a Concrete Specialty—Sales Methods—The Analysis of the Potential Market—Making Plans for the Future—The Lesson for Concrete Products Manufacturers

THE year 1910 found the members of the Detroit Concrete Receptacle Company doing some tall thinking. They had been making concrete garbage and ash receptacles for about one year, and had devoted a lot of attention to the job in order to produce a strictly first-class product. In that they had been successful,—everybody who saw their receptacles praised them. But one big problem remained,—what to do in order to get money in exchange for the receptacles.

The concrete products industry at that time was dominated by the concrete block business. That was the starting point for most every newcomer into the products business. And the only sales idea that the entire block industry had produced up to that time was, "Pile 'em up, and let them come and buy 'em."

The surprising thing was that this very unprogressive sales policy seemed to be all that was needed in order to sell blocks. Of course it didn't create any great concrete block magnates, but it did move enough stock for the makers to keep them in solvent condition. But when applied to concrete ash and garbage receptacles, it simply didn't work. Nobody came and bought them. And that's what started the Detroit Concrete Receptacle Company thinking.

Sales Experiments

Their problem as they saw it was to get their receptacles where the people that needed them would see them and observe their advantages. To this end they tried various expedients. One was to place the receptacles in grocery stores. Why? Because ninety per cent women shop there. This didn't work at all. Another thing they tried was enlisting furniture dealers as retailers. But here again there was something wrong with the idea and not many sales resulted.

Finally they asked themselves the question, "Where do people go when they want a garbage pail or an ash can?" The answer was obvious—the hardware store, of course. At last they were on the right track, for they had discovered the normal *trade channel* for merchandising their product.

When hardware dealers were approached, however, they did not jump at the idea of stocking a piece of bulky, unhandy merchandise which was unknown to their customers, and for which no demand had been created. But a plan was at length worked out with a few dollars under which they were to place a sample receptacle on their floor, and turn any orders they received over to the Detroit Concrete Receptacle Company for direct delivery, the hardware dealer simply collecting for this receptacle, and paying the manufacturer a fifteen per cent lower price for it, leaving himself a nice profit. The Detroit Concrete Receptacle Company in turn agreed to do a little newspaper advertising, listing the dealers, in order "to get things started."

This plan worked. Dealers began to sell the garbage and ash receptacles, and dealers who didn't handle them, began to get inquiries which made them excellent prospects.

The business became a good one, and as a result of plenty of sales work and a judicious amount of advertising, it has continued to grow from year to year unto the present time.

But with this growth there came another problem. A time came when further growth would necessitate enlarged plant facilities. But would there be any future growth? And if so, how much? Did their business have a limit, and what was it? Or could they count on indefinite growth, and at what rate? These questions all demanded answers before a proper decision could be made as to the enlarging of their plant.

Market Survey

And so a market survey was made. They first determined the number of detached homes within their sales radius which were situated on alleys where regular collection of garbage and ashes was maintained. Their own records showed them how many of these they had already sold, and a little calculation coupled with experience gave them a pretty accurate estimate of the proportion of the balance they could expect to sell, and the rate at which they could do it. They investigated and found out the number of new homes being built each year in their territory which they could regard as prospects. Here again experience told them what proportion they could expect to sell at once, and what proportion should be added to their deferred prospect list.

With this information in hand it was comparatively simple for them to calculate the probable future of their business, and it was only after they had done this that they went ahead with their plans for a new plant. Their recent experience has shown that their original estimates were not far wrong.

In all this there is a very direct lesson for the average concrete products manufacturer. First of all, the experience of the Detroit Concrete Receptacle Company shows quite conclusively that blocks are not the only things made of concrete that can be sold at a profit. In fact, the profit on specialties is generally much higher than on wall units, and in this particular instance it was notably so. And right here it may be worth mentioning that this concern made both ash and garbage receptacles. The garbage receptacles are good summer merchandise, and the ash receptacles go best in winter. That idea of balancing your line between seasons is worth thinking about.

There is also much food for thought in the way in which this firm sought its proper trade outlet, and in the way in which it analyzed its market before making plans for the future. The first provided them with a regular flow of business; the second gave them the knowledge that would protect them from either pessimism due to a temporary lull in business, or over-enthusiasm during boom times. Many thousands of dollars would be saved if every product man had such knowledge at hand on which to base his decisions.

From one angle or another, the experience of the Detroit Concrete Receptacle Company contains something of value to almost any man who is selling concrete products from the building block up. It is the story of a very signal success, and that against odds much greater than the average block maker ever encounters. Incidentally it blazes a path of almost certain success for any other manufacturer that may care to go into the business of making concrete garbage or ash receptacles.

Reinforcing Institute Convenes for Annual Meeting

Attendance records were broken at the Concrete Reinforcing Steel Institute's meeting at White Sulphur Springs, Virginia, on March 21st, 22nd and 23rd.

At the opening session, Charles F. Abbott, Executive Director of the American Institute of Steel Construction, New York City, spoke upon the subject "When the Horse-Trading Selling Methods Squeeze the Profits Out of Big Business." At the second session, Mr. H. J. Burt, consulting engineer of Chicago, addressed the members upon the subject of "Who Is Responsible?"

During the course of the business sessions, Chairman A. E. Lindau of the Grade of Steel Committee reported the results obtained by the committee at the conference on billet reinforcing steel held in Washington on March 19th. At this session also, Chairman Zabriskie of the Committee on Engineering Practice announced the completion of the Institute's Standard Specifications for a building code and its distribution to the building commissioners of 308 cities having a population in excess of 25,000.

George E. Routh, Jr., Vice-President of the Kalman Steel Company of Chicago, was elected President of the Institute. Mr. C. Louis Meyer, President of the Concrete Engineering Company, Omaha, was elected Vice-President. Hugh J. Baker, President of Hugh J. Baker & Company, Indianapolis, was elected Treasurer, and Mr. W. H. Pouch, President of the Concrete Steel Company, New York, and Mr. D. B. Knowlton, General Manager of the Dudley Bar Company, Birmingham, Directors of the Institute succeeding Louis Aronstam of Atlanta and Mr. P. J. Igoe of Newark, whose terms expired. Mr. M. A. Beeman was re-elected Secretary of the Institute. The appointment of Mr. R. W. Johnson as Engineer of the Institute was confirmed.

Construction Activities More Than Equal Those of 1926

Brisk activities in March brought the volume of construction during the first three months of 1927 up to a mark higher than has been registered during that period of any other year, according to statistics compiled by the Associated General Contractors of America.

The volume of work performed that month was 12 per cent greater than the February figure, and 13 per cent greater than the total recorded for March, 1926.

Meanwhile, the awards of contracts for future work have assumed a sturdy volume. The total for January and February of this year is equal to the combined figures for the first two months of the record-breaking year of 1926. The volume of contracts awarded during February shows an increase of 2 per cent over January and a rise of 16 per cent above the mark set in February, 1926.

The indications are that when the figures on volume of construction work carried on during this month are compiled, 1927 will be shown to have extended its leadership over previous years. An increase in April of 6 per cent over the March volume will give the present year the distinction of having seen more construction work under way during the first four months of the year than has ever been recorded in the past. The natural tendency toward an increase in the volume of operations during this season of the year is shown by the 25 per cent rise which April registered over March last year.

Condition of Steel Encased in Old Concrete

Some Observations on the Physical Condition of Iron and Steel After Being Encased in Concrete for a Long Period of Time

By CALVIN C. EVERHART

DURING the wrecking of the old Palmer House in Chicago (the State Street section) the writer had a chance to see a number of heavy limestone foundations removed from the saturated blue clay beneath this building. These foundations, including the sections of the heavy brick walls below the basement floor, were laid in a lime cement mortar, as near as the writer could tell from a physical examination. The mortar was in first class condition after being in saturated blue clay from 1871 to 1926.

The floors of this notable structure of the past were of fire resisting character. Brick and concrete arches were sprung between iron I-beams. The writer followed up the wrecking, and in no case did he find the iron corroded or pitted. However a light coat of rust covered all iron, the ends of the I-beams which rested on heavy brick walls also being free of corrosion. These walls were laid in a high-grade lime mortar. According to records at the Burnham library at the Art Institute, all iron I-beams in this building were imported from Belgium.

During the wrecking of the W. C. T. U. Building located at La Salle and Monroe Streets, Chicago, the writer made some close observations of the steel and concrete in the heavy floating foundations of this thirteen-story structure. The building was constructed in 1890, and was designed by the noted firm of architects, Burnham and Root.

These foundations were constructed of I-beams and railroad rails encased in concrete and resting on saturated blue clay a few feet above datum. A part of the steel had been painted with red lead, and part of it was encased unpainted.

Conclusions

Examination of this substructure during wrecking brought out and proved the following points: All steel which had been encased in rich grout was free from rust, the black mill scale on the steel still having its original luster. In cases where honeycomb existed, the steel was badly corroded and deeply pitted. This was particularly noticeable where the concrete was not perfectly dense between adjacent I-beam webs. Where pockets or voids occurred the same was true, showing that corrosion must have gone on within these pockets although some were sealed up by the other layers of concrete. The painted steel showed signs of deterioration under these conditions also. In dozens of observed cases the steel that was thoroughly encased in concrete or grout was found to be in perfect condition, painted or unpainted. Wrecking readily disclosed these points. It also brought out the fact that where water had saturated the concrete, the steel was badly corroded.

This bit of research brought out the point that thorough filling of all pockets and voids is of real importance. It shows that tamping and spading the concrete tightly around the steel may add years to the life of the steel and indirectly to the structure.

This removed work in general was of a high quality. The concrete was found to be dense and very hard. It was composed of Utica cement, coarse sand and hard limestone. The grout was dark in color and was extremely hard and dense, a fracture of it resembling granite. All concrete steel, etc., had been in place thirty-six years. The building was wrecked to make way for a much higher office and bank building.

Other Examples

An example of reinforced concrete and structural steel sidewalk construction came to the writer's attention, that of the west section of the First National Bank Building of Chicago. This work was constructed about 21 years ago. Upon the removal of the sidewalk slab in 1926, the supporting I-beams were found to be badly corroded, the upper flanges in particular. Three inches of limestone concrete covered the upper flanges, and one inch of this was a hard-finish wearing surface. The concrete seemed to be of a good quality as the workmen had to pick heavily to remove the old slab. The writer believes that surface dampness worked through the slab, and thus started progressive corrosion. This probably illustrates the necessity of a waterproofing between the structural slab and its wearing surface.

The last cases that came to my attention are of minor importance; they were noticed during the connecting of Wacker Drive to Michigan Avenue. Gunite placed about ten years ago was removed and the steel was found to be well preserved. A box girder was removed from the second level of the avenue. Its exterior surfaces had been encased in brick and stone, all steel surfaces had been painted, but the space between the girder webs was not filled. On these webs a heavy coat of rust had collected, and parts of this paint and rust had peeled off, carrying a fairly deep scale with it. This box girder was well above datum, but adjacent to the Chicago River.

Massachusetts A. G. C. Chapter Has Safety Committee

A committee on accident prevention, headed by Ralph U. Cross, has been appointed by the Worcester Chapter of the Associated General Contractors. Activities have already begun in an effort to carry on constructive educational work with the idea of increasing safety.

Mr. Cross is vice-president of the E. J. Cross Company, Worcester, Massachusetts.

Huge Concrete Boulevard Project in Los Angeles Completed

Two Mixers Used to Complete Large Pavement Contract in Record Time

THE largest concrete paving project undertaken by a municipality in Southern California and probably in the West, was completed recently by the city of Los Angeles in the improvement of Pico Boulevard for a stretch of 7.2 miles. The pavement is 70 feet wide for most of its length. The project contained 2,318,431 square feet of pavement.

This boulevard of super-highway proportions, contract for the paving of which involved over $1,000,000, now provides a traffic artery on the most direct route from the city to the ocean. It takes the place of a macadam roadway 20 to 30 feet wide, and marks the passing of a bumpy, uncomfortable riding surface and the opening of a smooth, modern highway.

Delivering materials to the mixer. The cement is stacked in piles of 7 bags each for a 7-bag batch

Time Record Made

The work performed under the single contract by the North Pacific Construction Company of Los Angeles was put through in record time, considering the difficulties encountered and the magnitude of the project. Preliminary operations were started in April of last year, concreting was begun June 18th, and although traffic has been using the entire surface since January, the finishing touches were not made until March. Three hundred days were allowed for the project.

In addition to the 2,318,431 square feet of 10-8-10 inch cement concrete pavement (thickened edge type), a $300,000 storm drain was included on separate contract in the major improvement.

Due to the widening and straightening of the alignment in the rolling country through which the road traverses, there was some unusually heavy grading as compared to ordinary municipal work. The excavation totaled over 152,000 cubic yards and cuts of 20 feet were necessary in some places. One fill was 50 feet and 7 major fills totaled 51,000 yards.

Two Mixers Used

In order to speed the work, two mixers were employed. The 70 foot width was placed in three strips of equal width. About two miles of the road's length is less than 70 feet wide because of delay in securing the right of way dedications, but on these sections pavement was placed to the full width of the secured land. The road is not less than 44 feet wide at any of these points.

The use of a longitudinal float insured a surface free from transverse waves

Traffic was maintained during construction, and al-

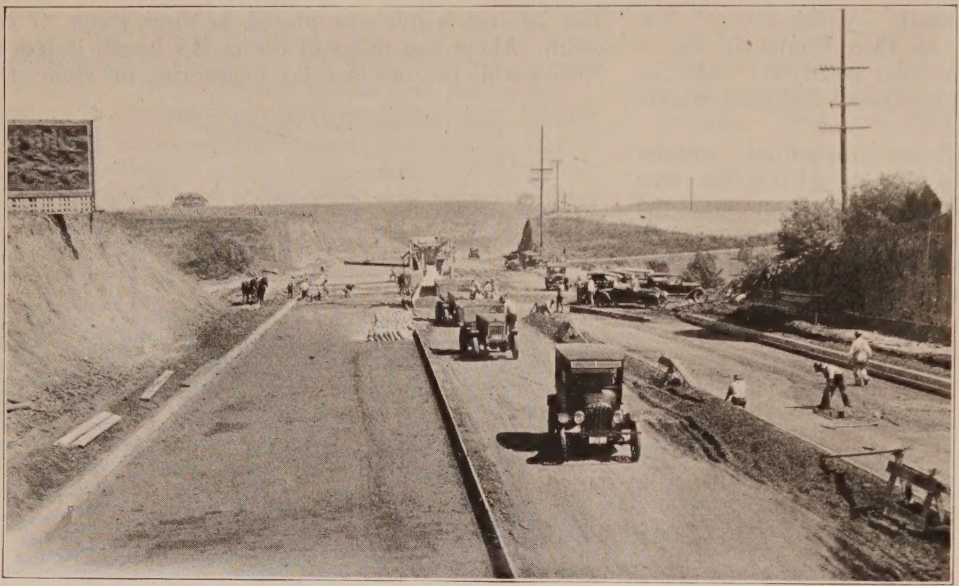
Traffic was maintained during construction by placing the new pavement in parallel strips though quite heavy in volume, the strip method of placing the pavement facilitated its handling. The outside strips were placed first while traffic used one side or the other, then the middle strip was filled in while single way travel was maintained on each side.

Each 23-foot strip has increased thickness at the edges. The central portion of the slab is 8 inches with the edges flared to 10 inches from points 3 feet from the edges. The strips are separated by ¼ inch Elastite. No transverse joints were used.

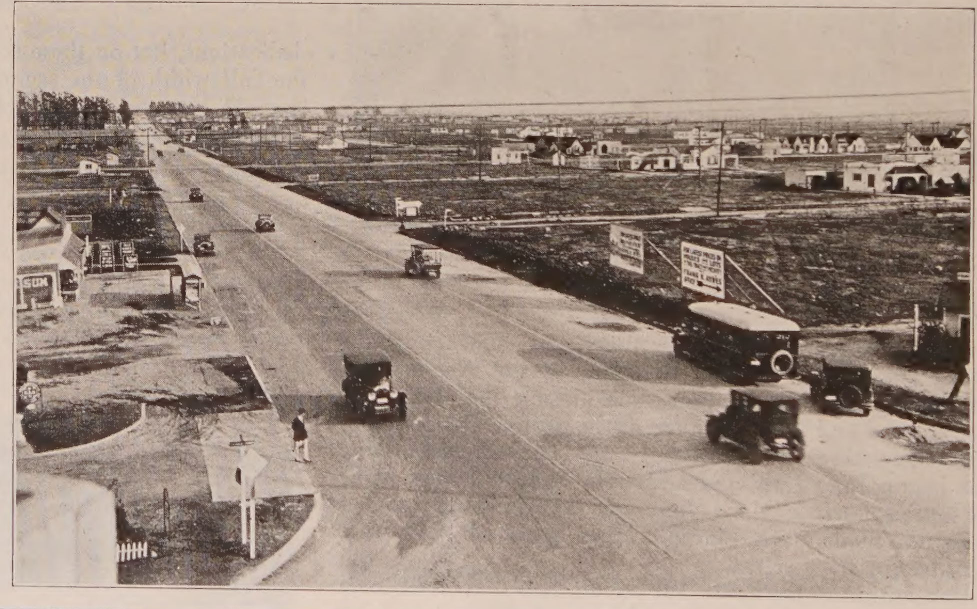
City specifications which call for a 1-2-3½ mix, with 2 inch allowable slump, 1 minute mix, longitudinal float finishing, and 14 day curing, under supervision of the inspectors of the Board of Public Works, resulted in good work. A smooth-riding surface is one of the outstanding features, and the delayed belting produced a true, non-skid texture.

A color coat distillate and lamp black, processed by one of the oil companies making a specialty of the product, was later applied.

Pico Boulevard now enters a period of service as a permanent major traffic artery. The pavement was placed under the direction of John C. Shaw, city engineer, Los Angeles.



The subgrade for the two outer strips completed while traffic uses the center strip



The completed pavement—70 feet wide

Michigan Products Men Organize County Association

Eighteen manufacturers of concrete products have organized the Kent County Concrete Products association, Grand Rapids, Mich., with the following officers: President, Harry Cromline; second vice president, J. A. Campbell; secretary-treasurer, C. T. Jenks. The officers, Garrett Dieterman and Charles Johnson comprise the board of directors.

City Plans to Lay Concrete Block Between Tracks

The city of Seattle, Washington, is expected soon to adopt the use of precast concrete block in street paving. City Engineer Walter H. Tiedeman has for some time experimented with the problem of paving between street railway trackage and has come to the conclusion that standard-dimension precast concrete block is the most practical solution.

Penstock Placed on Concrete Anchors

World's Highest Head Penstock Line Tied to Mountain Side by Means of Huge Concrete Anchors

ONE of the most difficult engineering feats in connection with the construction of the Balch Hydro-electric power plant (recently placed in operation in California by the San Joaquin Light and Power Company) was the anchoring of the 4,882 foot penstock line to the steep side of the mountain. While the penstock rests on concrete piers placed 30 feet apart, the problem of holding the line in place on the side of the mountain, which in some instances is almost perpendicular, was accomplished by massive reinforced concrete anchors, the largest being 42 feet long and 29 feet high. This anchor, placed at a bend in the line where the pipe is almost perpendicular, weighs 1,650,000 pounds and is designed to resist a horizontal thrust of more than one million pounds.

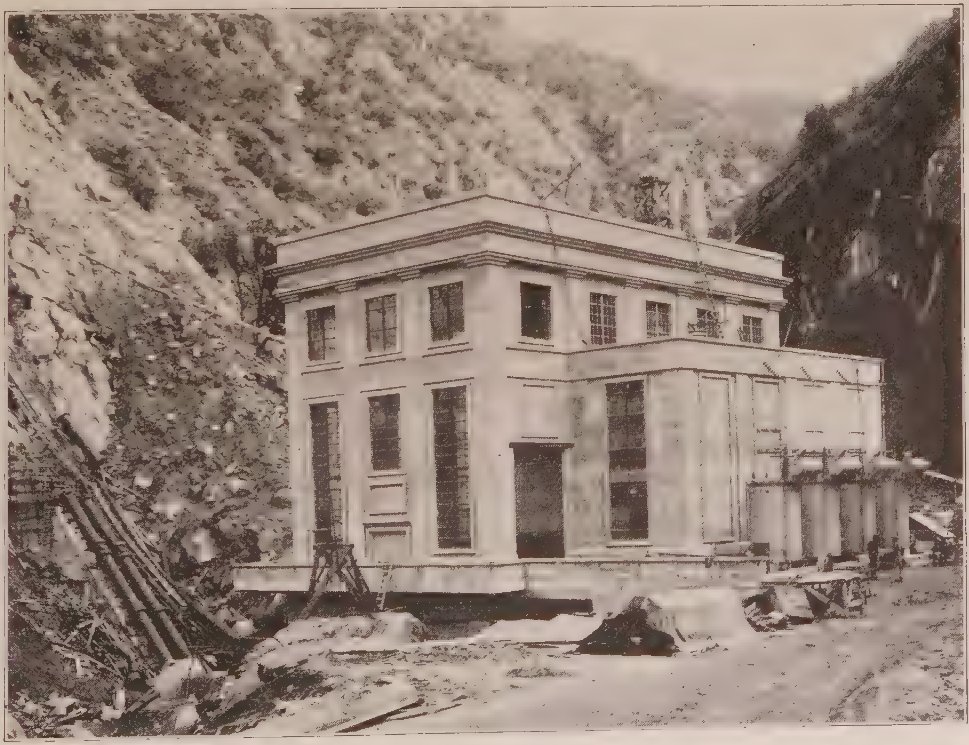
Provision for Expansion

The penstock line connects with a 19,500 foot tunnel through a concrete plug which provides for four 60-inch outlets, looking forward to the ultimate increase in the plant of four units. The diameter of the pipe decreases by increments of 4 inches to 48 inches at a point a few hundred feet above the concrete power house. At this point the penstock line is divided into two 34-inch lines which pass under the river in a concrete anchorage before reaching the power house. Because the canyon where the power house was located is steep and narrow it was finally decided to cross the river with the penstock in order to take advantage of a better side on the far side. The rock danger was also a factor in locating the power house away from the very steep slope down which the penstock comes.

Placing the Penstock

The dam at Williams Crossing. It is 85 feet high, 220 feet long and of 125 acre feet capacity

In placing the penstock under the river some interesting engineering features were involved. A trench was cut in the rocky river bed 4 to 6 feet deep in which the pipes were buried in concrete. But for additional security 3 rows of 1-inch steel dowels, placed 30 inches apart, were sunk into the rock 15 feet under the concrete an-



The concrete power house. At the left is one of the concrete anchors that tied the penstock line to the mountain side chorage. These were tied into heavy reinforced concrete forming additional anchorage against the force of the flood waters in the river.

The power plant is a reinforced concrete structure, the portion built for the initial unit is 82 feet long, 68 feet wide and 57 feet in height; ultimately the length of the power house will be increased to 206 feet to house the additional power units to be installed at some future time.

The water for operating the Balch power plant is diverted from the river by means of a concrete dam. This dam is 220 feet long at the crest, 95 feet above the deepest bedrock and 60 feet high above the stream bed. It is set in a narrow canyon resting on solid rock walls. This dam is merely intended to divert the stream through a 12 by 12 foot tunnel, 19,350 feet long cut through the solid granite of the mountain, conveying the water to the penstock. The turbines operate under a head of 2,381 feet, giving the Balch hydro-electric power plant the distinction of being the highest head plant in America at this time.

Architects' and Builders' Exhibit in East

A permanent architects' and builders' sample exhibition will be opened in Trenton, New Jersey, on May 2, to be known as the Architects and Building Samples Exhibition, Inc.

A few of the services available are an architects' library of building samples, conference and estimating rooms, and space for motion picture displays.

Dates Set for A. S. T. M. Meeting in June

Definite dates for the thirtieth annual meeting of the American Society for Testing Materials, have been set for June 20th to 24th at French Lick, Indiana. Monday, the 20th, will be devoted to committee meetings and the first session of the meeting will be held in the morning or afternoon of Tuesday, June 21st.

The A. B. C's of Making Good Concrete

THERE is a need for simple, non-technical information on the subject of how to make good concrete. Many text books, bulletins and treatises are available for the technical man. But it is not necessary to remember your calculus, analytical geometry or Latin—if you ever had them—in order to make good concrete. Everywhere there are men in the concrete industry who are not technicians. It is for them that Concrete is presenting in a simple, easily understood manner some of the principles that must be observed if better concrete is the aim.

All of these discussions will apply to all branches of the concrete industry. The rules for making good concrete are the same in principle for buildings, dams, highways or products.

It is not difficult to make good concrete. All that is necessary is to follow a few simple, easily understood principles and precautions that have proven of value on jobs everywhere.

Concrete is different from other building materials because it is made right out on the job instead of being delivered ready-made like lumber or bricks. It is this feature that gives concrete some of its advantages, but it is this feature also, that makes it necessary to control the making of concrete so carefully if the best possible concrete is wanted. The concretor really sets up his factory for manufacturing concrete right at the job, and like in any factory, the manufacture of the product must be carefully watched.

THERE are certain details that must be controlled if good concrete is wanted. Ignorance or carelessness in any one of these may result in poor work. On them depends the quality of the concrete. Experience has shown that these details *can* be controlled in the field in a practical, common-sense manner. In fact it has been shown that if the principles of making good concrete are followed, the cost of the work is reduced.

Primarily, the concretor is interested in *results* rather than methods. But because methods determine results, he must know when wrong methods are being used and how to correct them. He should be able, for instance, to pass on the quality of the materials available—whether they are suitable for use in concrete or not, and if they are, how they can be combined to get the best concrete for the least expenditure. He should be able to tell with certainty whether or not he is proportioning his materials correctly. Then there are the simple principles of proper mixing, placing and curing, all of which affect the quality of the concrete in the structure.

IN succeeding numbers of Concrete these principles will be explained. Articles will tell you just how to go about making good concrete. The first of these will describe a number of simple tests that can readily be made in the field to determine the suitability of aggregates. The second will discuss the effect of moisture in the aggregates and will tell how to measure it and allow for it in the mix. Other articles will cover these subjects: The Amount of Mixing Water, Workability of Mixes, Effect of Mixing Time, Effect of Curing, Winter Precautions, How to Make Dense Concrete, etc.

EDITORIALS

Concrete in Architecture

THE importance of the place of concrete in architecture is steadily being more generally recognized. Its increasing uses, both for its structural and its ornamental qualities, is a fact easily determined by observation and by examination of construction statistics.

But a more significant and important indication of its growing popularity is found in the less obvious but definitely increasing appreciation in which it is held by architects and builders. The recent architectural session of the American Concrete Institute, attended by a delegation from the Illinois section of the American Institute of Architects, is one indication of this growing interest. The papers read at that session, abstracted on other pages in this issue, prove that capable architects have accorded it an important place in present day building development.

That designers in concrete have not yet realized its full possibilities is due to the self-imposed limitations brought by adherence to the customs and traditions that center around the other, older building materials.

Concrete, architecturally at least, is a new building material. It must be treated as such, free from the restrictions that do not apply to it. Gradually it is being realized that concrete need not be treated as a substitute building material—that it has possibilities for beauty that are peculiarly its own. It is only by considering it in that light that concrete will reach its deserved place as a medium of architectural expression.

Waging War Against Fire

THE work of the National Fire Protection Association of New York deserves the active support of all concretors. This organization, with 145 association members and 4,100 individual members, is engaged in waging systematic war against fire through field research and educational work.

Whether he realizes it or not, every concretor is helping to make his community safe against fire. Every new reinforced concrete structure, every concrete block house, every new concrete tile roof is a move toward greater protection against fire.

The fact that concrete structures are fire-safe is one of the most important sales arguments the concrete products manufacturer and the concrete roofing tile manufacturer can use. It is largely the desire for fire-resistant office, school, hospital, apartment and industrial buildings that has given the concrete contractor an outlet for his services.

Any movement that stresses the present great need for fire-safe structures and calls attention to the unnecessarily large fire losses suffered in the United States merits the whole-hearted backing of concretors, if only for the reason that it presents to the building public a forcible reason for building with concrete. Besides, there is the humanitarian side of the question. The concretor is an active influence in lessening the yearly toll of fire which now causes a loss of 15,000 lives and $550,000,000 in property annually.

Better Proportioning

ENGINEERS and contractors are properly placing increased emphasis on the matter of better proportioning of concrete aggregates. Several methods of combining materials in more effective proportions are in use. All of them work toward the same end—better concrete.

One objection to the old-style method of arbitrary proportioning is that it produces concrete of widely varying strengths, sometimes as much as 15 to 20 per cent above or below the average for the job. The same materials, properly proportioned, will give not only higher strengths but more uniform concrete.

Another objection is that acceptable aggregates are limited to certain definite sizes, even though other aggregate which could be obtained locally at lower cost, would, if combined with the proper amount of cement and water, produce equally good concrete.

It is now definitely proved that the strength of concrete depends upon the amount of mixing water used. The strongest concrete is that which, while plastic and workable, contains the least amount of water. It has also been shown that certain combinations of aggregates produce workable concrete with less mixing water than others.

Thus the amount of mixing water determines the strength of the concrete and the grading of the aggregates determines the amount of mixing water needed to secure a workable concrete. Proper grading of aggregates is, therefore, a most important item in making concrete.

The proportions in which aggregates are best combined can be determined by several methods—the fineness modulus method or the trial method, both of which have been described in these pages. The important point is to determine by some means those proportions that give the most workable mix with the least amount of mixing water.

These methods permit the use of materials of an infinite number of different sizes and gradings without changing the strength of the resulting concrete. They determine the amount of mixing water to be used. They produce concrete of a more uniform consistency. And they make possible the design of concrete of predetermined strength.

Four Important Factors in the Manufacture of Concrete Pipe for Alkali Soils*

An Outline of Tests Showing the Factors That Lead to High and to Low Resistance of Concrete Pipe When Exposed to Alkaline Soils, with Suggested Procedure in Manufacture and in the Selection of the Right Cement for the Work

By D. G. MILLER
Drainage Engineer, Division of Agricultural Engineering, Bureau of Public Roads
United States Department of Agriculture

NO way has yet been found to make portland cement concrete that entirely resists all alkali action, but much has been learned of the very great influence exerted by the following four factors: (1) alkali resistance of the cement; (2) quantity of cement used in the mix; (3) quality of the concrete as measured by the 28-day compressive strength; and (4) conditions under which the concrete is cured.

By careful consideration of these four factors portland cement concrete pipe can be made that will be entirely satisfactory for use in alkali soils where the total content of the sulphates of magnesium ($MgSO_4$) and sodium (Na_2SO_4) is less than 2500 parts per million, while pipe made with extreme care may satisfactorily resist even much more severe conditions, the exact limits of which have not yet been fixed.

These four factors will be considered in the order in which they have been enumerated but which is not necessarily that of relative importance as all the items are more or less closely related and are somewhat difficult to classify as to individual importance. It will here be emphasized though, that consideration must in all cases be given the alkali resisting properties of the particular cement used and the conditions under which the concrete is cured if resistant concrete is to result. The importance of these two items is particularly stressed for the reason that heretofore little or no consideration has been given them in the making of concrete which later is to be exposed to alkali soils or waters.

Alkali Resistance of the Cement

In calling attention to the fact that there is a wide variation in resistance of different brands of portland cement it will be said that furthermore there appears to be a considerable difference in resistance of cements of the same brand manufactured at separate plants.

In Figure 2 is shown results of tests of cylinders from 15 series after one year exposure to 1 per cent solution of sodium sulphate while in Figure 3 is shown a view of a representative cylinder from each of the 15 series after 15 months exposure. In this group all cylinders were identical except that a different brand of cement was used in each of 12 of the series. Cement No. 61 was a mixture of equal parts of cements Nos. 62 and 63. Of the 75 cylinders tested from the solutions only 3 had a strength ratio greater than 100 per cent as compared with 75 cylinders from the same series stored in tap water in the laboratory. The 3 cylinders were made with cement No. 41 and as a consequence this series at one year finished with a strength ratio of 101 per cent so that the condition of the cylinders in the various series ranged all the way from normal strength to complete disintegration.

The point may be raised that the order in which these cylinders finished at one year may have been more or less accidental and that other lots of the same cements might give entirely different results. Such, however, has not proven to be the case in other tests in the laboratory as given cements have in all cases shown consistent results.

In view of the wide variation in resistance of different brands of portland cements the first essential in making concrete for alkali soils is the selection of the cement. Some little effort has been made in the laboratory to work out an accelerated test by which the resistance of a cement might readily be determined. Results along this line though have not yet been entirely satisfactory and, until a satisfactory accelerated test is developed, the following recommendations are at this time made with the idea that cements very low in resistance can be eliminated from consideration for use in concrete for alkali soils and that, instead, cements of at least average resistance will be selected. For the present, if only this much can be accomplished, considerable progress will have been made in the whole concrete-alkali problem as the work in the

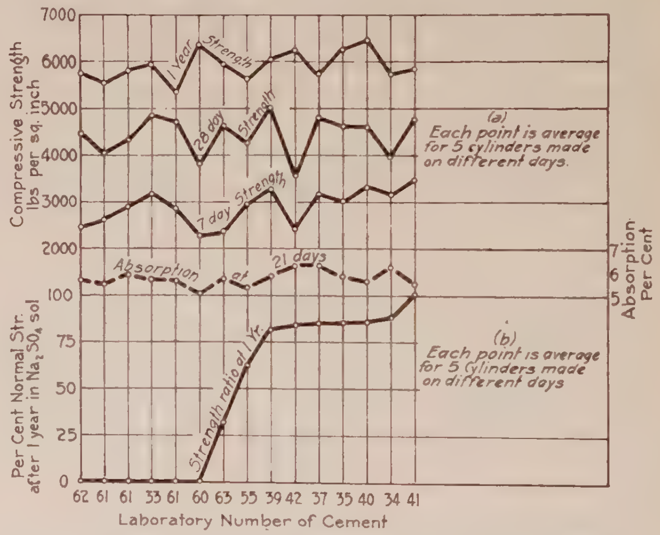


Fig. 2. Comparison of (a) strength and absorption of concrete made of different brands of portland cement and of (b) relative resistance to 1 per cent solutions of Na_2SO_4 as indicated by compression tests after exposure for one year. Series 261-275

laboratory with something like 30 cements apparently justifies the conclusion that of the many brands on the market a very appreciable number of the total are entirely unfit for alkali soils.

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*A paper read at the Land Reclamation Session, annual meeting of the American Society of Agricultural Engineers, Lake Tahoe, California.

University of Minnesota paper No. 625 Journal series. This report is the result of experiments at University Farm, St. Paul, Minnesota, in the drain tile laboratory conducted by the Department of Agriculture of the University of Minnesota, the Department of Drainage and Waters of the State of Minnesota, and the U. S. Department of Agriculture, cooperating.

Each Cement Constant

There is no reason to believe that the resistance of any cement greatly varies from time to time so that once it has been established that a given cement is at least of average resistance future tests need be made only often enough to make certain that there has been no change. Consequently the time element involved in the test suggested is not as objectionable as at first thought might appear.

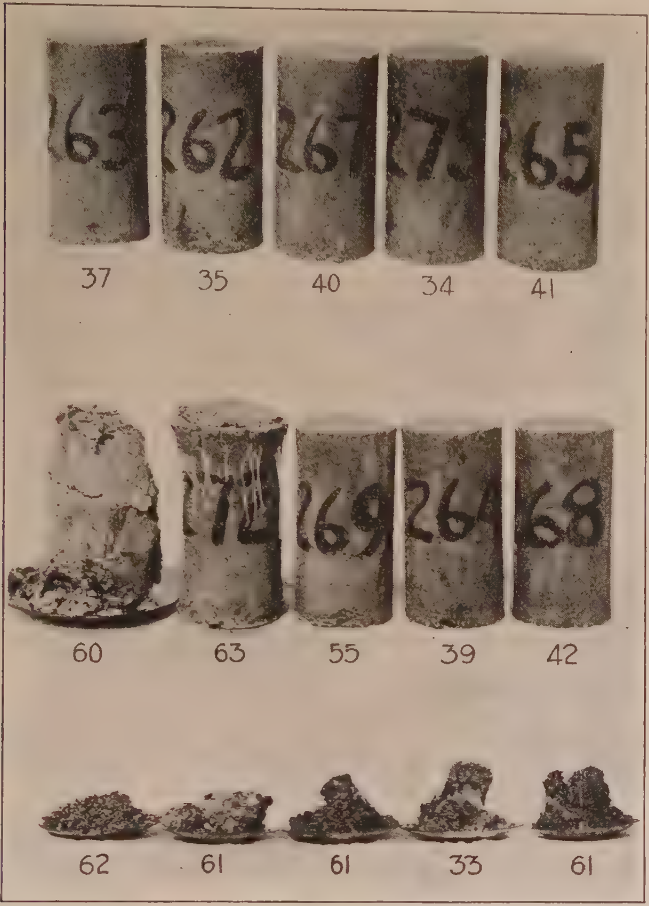

Fig. 3. One representative cylinder from each of the 15 series, upon which are based the graphs of Figure 2, after 15 months in 1 per cent solutions of Na_2SO_4. These cylinders were identical when made except that different brands of standard portland cements, with laboratory numbers as indicated, were used. At 32 weeks the series with cement 62 tested 31 per cent of normal strength while at 1 year the series with cement 41 tested 101 per cent. The other cements gave results between these two extremes

The cement was tested for resistance by first making up 3 or more standard sand mortar briquettes composed of 1 part cement and 3 parts standard Ottawa sand, by weight. In making these briquettes the 1924 standard specifications of the American Society for Testing Materials were carefully followed. After about 20 hours in the moist closet the briquettes were stored in distilled water and at 7 days tested for tensile strength. Retaining the two halves of each briquette and, without permitting them to dry out, one half was stored in a 1 per cent solution of magnesium sulphate ($MgSO_4$) and the other in a 1 per cent solution of sodium sulphate (Na_2SO_4). To make up these 1 per cent solutions, on the basis of anhydrous salts, 80 grams of magnesium sulphate or 88 grams of sodium sulphate were required per gallon of water. The solutions were kept, about 3 gallons to a jar, in 5 gallon earthenware jars, covered to reduce evaporation, and the solutions were completely changed every 4 weeks. The temperature of the solutions was maintained as near 70° F. as practicable. The specimens stored in the jars were subjected to close visual examinations at intervals for a period of 6 months.

Results of Treatment

Briquettes made and stored under the conditions outlined showed but little evidence of disintegration, to the extent perhaps of a slight rounding of the edges, at 6 months, the cement used being of average resistance. More than slight evidence of action on briquettes in either solution should be grounds for rejecting the particular cement for use in alkali soils. Briquettes made of cements very low in resistance, when subjected to this test, will have almost completely disintegrated at 6 months.

The value of the test as outlined will be greatly increased if briquettes made of several different portland cements be included so that at all times a basis may be had for comparing the behavior of different cements under identical exposure conditions. Probably no fewer than 5 cements should run simultaneously, and a larger number is desirable, for in a group test the greater the range in resistance of briquettes made of different cements the more evident will be the failure of any cement that falls well below the average.

In this paper the resistance of high alumina cements has been considered only very incidentally. It will be said though that, in general, *experiments in the laboratory*[1] *have indicated that apparently under all conditions* they have much greater resistance to sulphate waters than have any of the portland cements.

Quantity of Cement

The richer the mix the more resistant the concrete, other factors being the same. It is, however, only when the mix becomes richer than 1-2 that outstanding results are to be obtained in this manner so that improvement so gained must necessarily be at considerably increased cost and especially is this true when high resistance is required as the greatest value of enriching the mix is not realized until it becomes as rich as 1-1. These points are illustrated by the curves of Figure 4.

This is a matter that will not be gone into in any detail in this paper but, in general, all factors being the same, the concrete with the highest 28-day compressive strength is the most resistant. However, the value of such a test for alkali resistance has its limitation as it in no way indicates the difference in cements (See Figure 2) nor does it give any indication of the comparative resistance of concrete cured under different conditions. This latter point is clearly brought out in Series 21-25 of the group of cylinders upon which Figure 5 is based as the order of these series in alkali resistance has been 22, 21, 24, 25 and 23 while that of the 28-day compressive strength was 23, 24, 25, 22, 21. To make this clearer Table I is inserted for consideration along with Figure 5.

Table I. Curing conditions, 28-day strength and order of resistance to alkali of cylinders in series 21-25 upon which the graphs of Figure 5 are based:

Series No.	Curing Conditions	28-Day Compressive Strength, lbs. per sq. in.	Order of Resistance to Alkali
21	2 days in steam at 212° F.	3330	2
22	6 days in steam at 212° F.	3490	1
25	6 days in distilled water	4160	4
24	2 days in distilled water	4470	3
23	20 days in distilled water	4750	5

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[1] Alumina Cements and Sulphate Water. Concrete, Vol. 28, No. 4, April, 1926.

Curing Conditions

That concrete may develop maximum alkali resistance to soil alkalies careful consideration must be given the curing. It has been found that by merely varying curing conditions that cylinders identical in all other ways show a wide range of resistance. This point has already been developed in part in the preceding paragraph in which attention was called to Figure 5 showing the remarkable results obtained by curing cylinders in steam in a temperature of 212° F. as compared with water curing. The value of long air hardening subsequent to the curing period in moisture is illustrated in Figure 6 based upon 10 series in which the air hardening period preceding exposure to the solutions has ranged from 0 to 49 weeks.

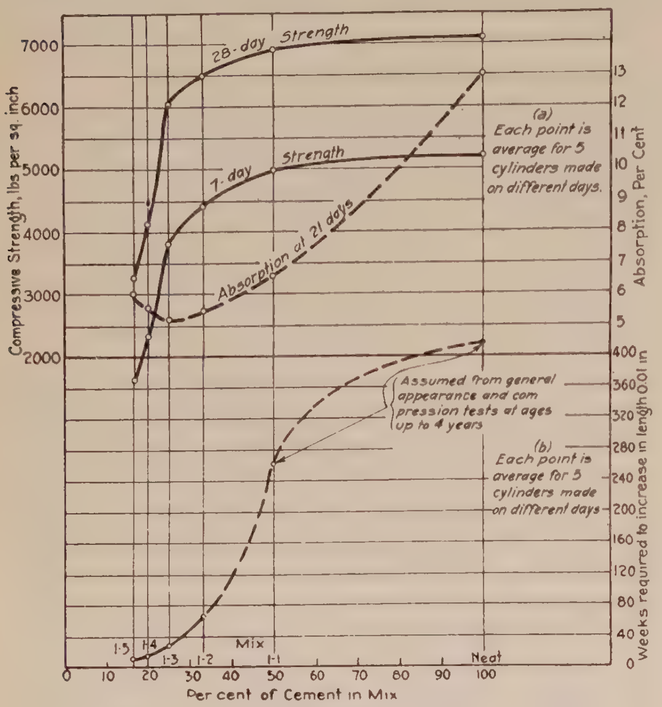


Fig. 1. Influence of varying the time interval of solutions renewal on life of two types of concrete cylinders stored in 1 per cent solutions of Na_2SO_4. Series 38-40

In connection with the results of the curing experiments illustrated in Figures 5 and 6 it is of particular interest to note that the cements used in both these groups were the same brands as cement No. 61 which made such a very poor showing in comparison with several other brands as indicated in Figures 3 and 4. It therefore seems reasonable to conclude that by properly curing concrete made of high resistant cement that extremely resistant concrete can be produced, in many cases, at little or no increased cost.

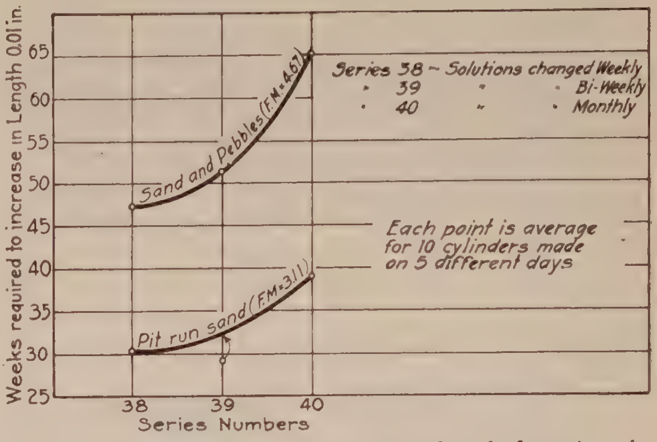


Figure 4. Influence of mix on (a) strength and absorption of concrete and (b) on 1 per cent solutions of $Mg SO_4$. Series 8-16-20

Recommendations

For concrete to be exposed to the action of sulphate waters the foregoing may be reduced to the following recommendations:

(1) Make a laboratory test of the cement for resistance in accordance with the routine as outlined in this paper. By so doing cements very low in resistance may be rejected thereby certainly eliminating, at no additional cost,

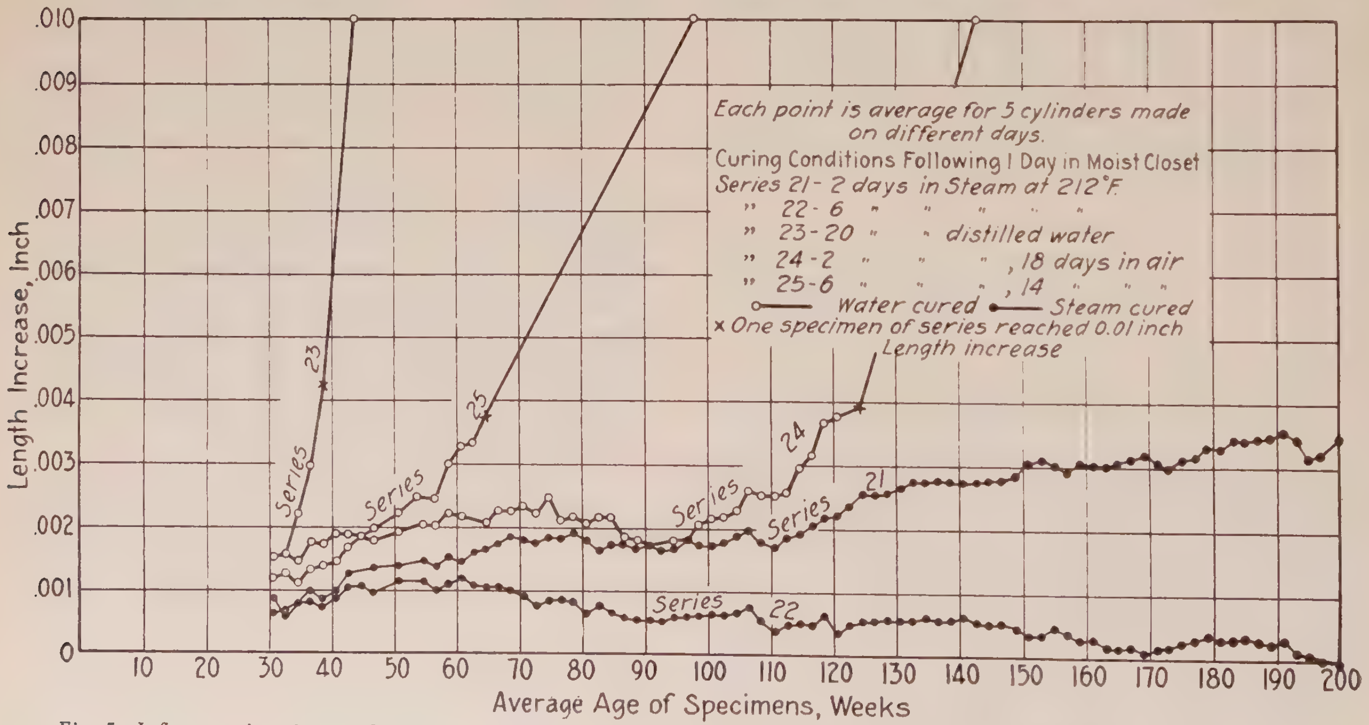


Fig. 5. Influence of curing conditions on change of volume of 2x4-in. portland cement concrete cylinders stored in 1 per cent solutions of $Mg SO_4$. Series 21-25

early failures of well made concrete almost regardless of exposure conditions. Only those cements of average, or above average, resistance should be considered where the soil or water conditions are known to be bad.

(2) Where the work is of sufficient importance to justify the cost specify a mix of 1-2 or even 1-1 with portland cement and 1-4 or 1-3 with high alumina cement.

(3) Careful consideration should be given all factors which will produce the highest 28-day strength concrete with any given cement for any predetermined curing condition for within these limitations the 28-day strength is a good indicator of resistance. This is particularly true when high strength is the result of a rich mix.

(4) After the concrete is made keep sulphate bearing waters from intimate contact until the concrete has had an opportunity to dry and harden in air for the longest time practicable for the job at hand. The longer the concrete hardens the greater the resistance and this period should in no case be less than 30 days while 90 days or more is of great value. To develop greatest resistance steam cure when not less than 24 hours old in a temperature of 212° F., or higher, for 24 hours, or longer. All these curing conditions are particularly applicable to the manufacture of concrete pipe and pre-cast products.

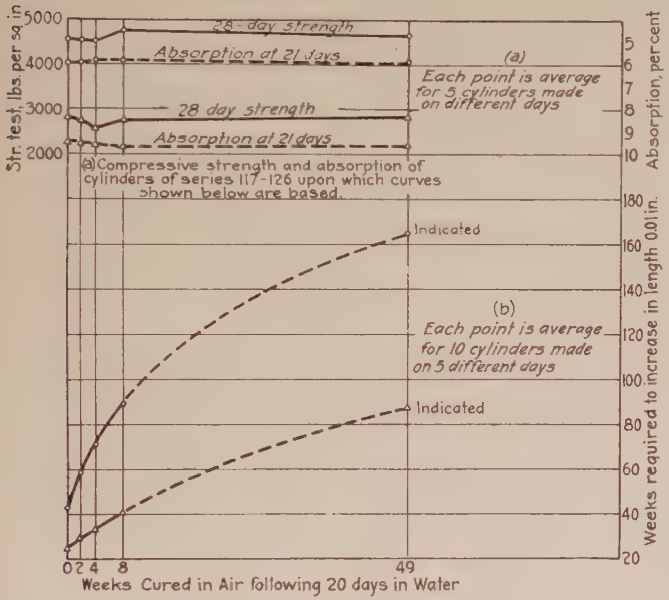


Fig. 6. (b) Influence of air curing on the life of concrete (—·—) and Ottawa sand mortar (—x—) cylinders stored in 1 per cent solutions of Na_2SO_4. Series 117-126

General Remarks

This paper is based chiefly on experiments in the laboratory with cement concrete and cement mortar cylinders stored in artificial solutions of the sulphates of magnesium ($MgSO_4$) and sodium (Na_2SO_4). In formulating the conclusions consideration also has been given the first year's test results of experimental cylinders and drain tile installed under field conditions in alkali soils and water in Minnesota, North Dakota and South Dakota. As the purpose of this work has been primarily to determine the limitations of the use of concrete tile in alkali soils the types of concrete considered have for the most part been such as might be suitable for the commercial manufacture of pipe. In these studies there have been made a total of about 20,000 cylinders and 2500 drain tile.

A report covering these experiments in detail has been prepared and has been issued as a University of Minnesota Bulletin. It is, therefore, the purpose at this time only to present in condensed form what have been found to be some of the more outstanding essentials in concrete making that develop greatest resistance to alkali.

Laboratory Routine

The length of this paper does not permit a description in detail of the laboratory routine and cylinders. Mention, however, is made of such points as is believed make possible a clear understanding of the data presented.

All cylinders in solutions in the laboratory are stored in earthenware jars and the solutions changed at intervals of one or two weeks. It was found, as indicated by Figure 1, that this change must be regular and frequent if consistent results were to be obtained.

Two by four inch cylinders have been used in this work as this size reduced to a minimum the volume of concrete in all jars. Moreover, the 2-inch diameter roughly approximates the thickness of the wall of the average size of tile used in larger drains.

The cylinders are made in batches of nine, each series consisting of five batches made on different days. In each end of three cylinders of each batch a 1-inch brass screw is set in neat cement. Changes in volume are determined by measurements between screw heads and it has been found that an increase in length of 0.01 inch in a 2x4-inch cylinder ordinarily indicates a 50 to 70 per cent strength loss. The laboratory standard concrete cylinder is mixed 1:3 by volume with a consistency of 1.00 (water ratio .60) and the aggregate graded to produce a fineness modulus of 4.67, the largest pebbles used passing a three-eighths-inch screen. Some few series of mortar cylinders have been made of standard Ottawa sand with the idea that they fairly well represent poorly graded aggregate as too often used in smaller size tile.

Extreme care has been exercised in making the experimental cylinders of a series that they be as uniform as possible and variables have been introduced singly in the different series that the influence of any variable on the life of cylinders of a series might definitely be ascertained and recorded.

Reinforced Slab Flooring for Bridges Reported General

The U. S. Bureau of Public Roads reports that general adoption of the concrete floor has been retarded to some extent by the unsatisfactory experience with the older type, used extensively in and near cities, consisting of a concrete bed for block or bituminous surfacing carried by steel buckle plates. This was the type used before the adoption of reinforced concrete slabs, and is said to have been expensive both to construct and to maintain. The defects usually noted are broken buckle plates, especially where the buckle is turned up, broken and loose concrete, and frequent expensive repairs resulting from the breaking up of the pavement and holes in the floor.

"The reinforced slab design is not open to these objections; and in common with the older type it possesses the very desirable quality of rigidity which inspires the confidence of those who ride over it," the Bureau's report continues. To the engineer it suggests the idea of heavier weight, and the first thought is likely to be that extra steel will be required to carry it, so much, perhaps, that the cost of the bridge with concrete floor may exceed the cost of a timber-floored structure.

"So far as the trusses and floor beams are concerned this assumption is correct but on account of the possibility of using deeper I beams for stringers and a wider spacing the saving in stringer weight may be nearly enough to compensate for the increased weight of trusses and beams."

Here and There

Some Random Notes on Visits with Concretors in the Field

IT is interesting (and instructive, too) to know that in the annual depreciation rates generally accepted by the Treasury Department for income tax returns, concrete carries away the honor of being the lowest.

Depreciation on concrete buildings is rated at only 2 per cent per year, while some other types mount to 10 per cent. All other classes of buildings generally considered "fireproof" or "permanent" carry higher rates.

* * *

HOW many products manufacturers can say definitely just how much each operation in making concrete block costs? What percentage of the total cost of the block goes into the various items that make up the cost?

One products manufacturer gives these percentages. It will be interesting to compare them with your records.

	Per Cent
Cement	38
Aggregate	15
Labor	20
General Overhead	27

Labor, as figured in this analysis, includes direct plant overhead, that is, fuel, power, upkeep of machinery, incidental repairs and curing room heating. General overhead includes salaries of officers, salesmen, advertising, depreciation, rent, office supplies, etc.

The costs were figured on a plain 8x8x16 block on a basis of 200,000 block per year production.

* * *

ONE evening, driving along one of the main streets of a large city, we saw a large floodlighted sign—"John Doe Concrete Products Co." The plant was located near the center of town on one of the streets that led to a main traveled highway.

That sign has aroused the curiosity of local motorists and has led to some sizable orders for concrete block. Of course, the plant was progressive in every other respect, as might be expected from a manufacturer who believes in advertising.

* * *

"HE is a pretty busy man, and hard to see," was the encouraging response we got when we asked for the manager of a business-like products plant in a city of about 30,000. "He is attending a meeting of the Chamber of Commerce now. He is president, you know."

Here was a products manufacturer that had the right idea. He is interested in every civic movement and is rated as one of the big business men of the city. Because of his activity in civic affairs, he was able to put across a modern, fair, building code that meant a lot to the concrete products industry in that city. He is in close touch at all times with all developments of importance and when these developments involve the building of homes or factories, he is on the ground floor and ready to advocate the use of concrete products.

A NOTED architect, who recently discussed the subject of concrete floors, made some very interesting statements. He said, among other things, that "most concrete floors have not yet developed beyond the sidewalk stage. If half the thought and time and money had been expended on perfecting the concrete floor that has been spent on developing wood from the rough board sidewalk to fine parqueted flooring, everybody would want concrete.

"Concrete floors are cheaper than wood for the first floor; they are enduring; they require a minimum of care; they are comfortable and healthful when properly laid and they can be more beautiful than any other floor."

And an architect always makes conservative statements!

* * *

NOT long ago, several 6-inch cubes were sawed from a slab of concrete pavement in Bellefontaine, Ohio. This pavement was placed in 1894 and is still in use. When tested, one of these cubes showed a crushing strength of 5,400 pounds per square inch.

Even under the methods of concrete mixing and placing then used, the Bellefontaine pavement yielded durable concrete. A recent inspection of this pavement showed it to be in excellent condition, even though its appearance is slightly marred by worn longitudinal joints which divide the pavement into 5-foot slabs.

* * *

IN looking about for a profitable specialty to supplement his concrete block sales, one products manufacturer decided to manufacture porch coping and porch rails. That fitted in well with the manufacturing and selling of concrete block for house construction and the first year netted him the contracts for supplying the materials for ten porch railings. This year the number will be considerably greater.

* * *

THE Own Your Own Home Show was held at Chicago during April. There were more concrete exhibits than ever before—an indication of the important place that this material holds in home building.

Concrete tile for roofs; concrete block and concrete brick for walls; concrete stucco for exterior walls; concrete plaster for interiors and concrete garden furniture were very much in evidence. In almost every department of home building, concrete was exhibited as a practical, beautiful and durable medium of construction.

Most of the homes built for exhibition purposes had concrete tile roofs, whether the home was of brick, timber, or of concrete units. In one very attractive display, the close co-operation between a concrete roof tile manufacturer and a brick association was very evident. The roof tile man said that he was able to co-operate with the brick people better than with the concrete industry. Perhaps we in the concrete industry have not yet learned the value of co-operative effort as well as we ought to.

Building a Two-Level Street in Downtown Chicago

A Description of the Design and Construction Features of Wacker Drive—An Unusual Concrete Construction Job

Part III—Construction Features

By STANLEY H. LOMAX
Section Engineer, Board of Local Improvements, Chicago

Parts I and II of this series of articles, describing the construction of Chicago's Wacker Drive, were published in previous issues. They described the methods used in controlling the quality of the concrete that went into the structure and the design problems of the structure itself. In this, the third article of the series, the methods used in overcoming the peculiar construction difficulties are presented.

FROM the chaos of the old South Water Street Produce Market, to the present efficient two-level traffic artery known as Wacker Drive, is to the eye of the average laymen but one of those incomprehensible, easy steps so common to a thriving municipality having a keen sense of pride among its civic leaders. First they see a busy market place, with its attendant teams, trucks, noise and odors, then the many hurrying laborers, the puffing, screeching steam shovels, the slow, deliberate dredges, the clanging pile drivers, and the colony of tent-like structures housing the caisson equipment. Gradually the scene changes to a forest of timbers, the supports for the form work. Slowly the deck work is framed, the maze of reinforcement placed, the concrete placed, the pavement laid, the stone trim and ornamental light poles installed, and the Drive opened to traffic.

Operations Scheduled

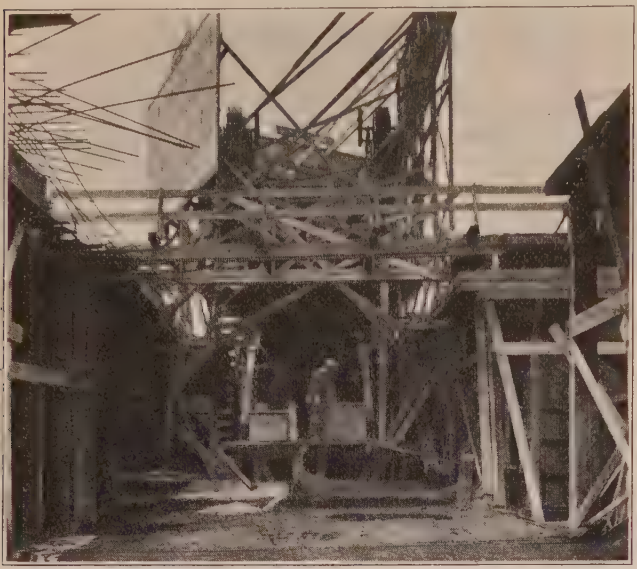
To the mind of the technical man there immediately comes the thought that behind this metamorphosis, there was a definite scheme of operation and that many interesting problems arose, which is indeed the case. After the ordinance authorizing the project was passed, the construction program was mapped out. At this time, business was going on full blast, along South Water Street. The complete undertaking was divided into sections, one block in length and including its easterly intersection. In order to induce competitive bidding, groups of these sections were let as independent structures. The merchants were duly notified to move and the wrecking of existing buildings along the river front began. In many instances the roof, upper floors and even the back of the buildings were

In spite of the adverse construction conditions encountered, not a man was killed or seriously hurt during the construction of Wacker Drive. This record was the result of a strenuous safety campaign carried on throughout the job.

being removed while business was still being carried on in the front room and on the sidewalk. Here, under the most adverse conditions was started a strenuous campaign of "Safety First" which was carried on to the conclusion of the work and it is now the boast of all connected with the job that not one man was killed or seriously injured on Wacker Drive.

Caisson Construction

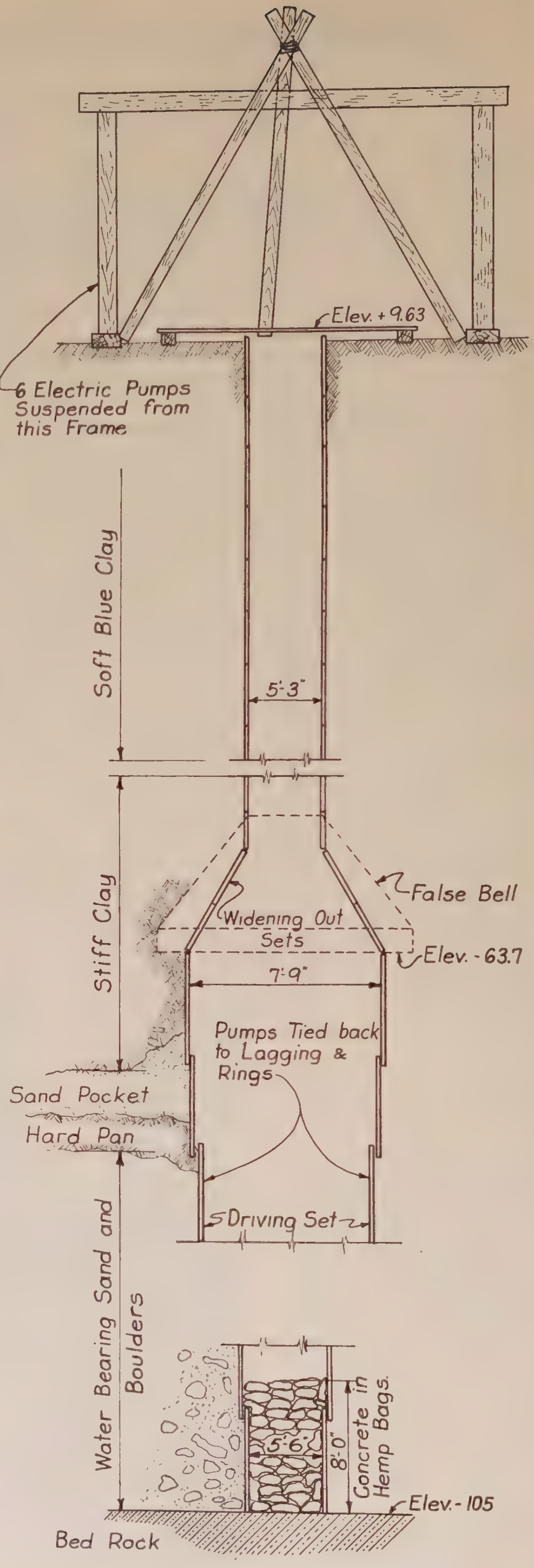
The caisson work progressed rapidly under similar conditions as might be encountered any place in this locality. The character of the soil at the site of the Drive is: Top soil principally fill, below which is a glacial deposit consisting of a soft blue or yellow clay, under this there is a layer of stiff dark clay and shale containing large boulders of silicious limestone with embedded deposits of calcite. At elevation -70 to -80 below City datum a so-called hard-pan formation is found meeting the requirements of a bearing test of 7 tons per square foot. Here the shaft was belled out to give the required bearing area, the bell sealed with concrete, such reinforcing placed in the shaft as was required, and the shaft poured to its proper elevation.



Showing the mixing plant, located on the lower level

In many of the caissons, sand pockets were encountered and in several a strata of water-bearing sand was passed through which necessitated constant pumping. The method of pumping, widening out the caisson, placing driving sets and packing behind the lagging with straw, burlap and other materials was adopted where water and sand were encountered due to the fact that pneumatic air lock equipment was not available through any local concern, and the attendant delay necessary to bring this equipment from New York would seriously hamper the progress of the work.

In only one instance was it necessary to go to bed rock. Here an exceptionally deep sand pocket was found and when this was removed the layer of hard-pan was of insufficient depth to provide the required bearing. From this elevation to rock proved a great fight, requiring a month and a half working 3 shifts and the continuous operation of 6 electric pumps to go 19 feet. When it was discovered that it would be necessary to go to bed rock, it was imperative that the well be widened out to permit the subsequent loss of cross sectional area due to placing driving sets of lagging. The diameter was, therefore, increased to 7 feet 9 inches in two 5 foot 3 inch lengths



SECTION THROUGH CAISSON

of lagging and digging was resumed. The flow of water into the well increased with depth until the widened portion was lined with pumps suspended from a special timber frame above, leaving a passage through the middle just large enough to pass a man. The last few days the men worked in water almost up to their armpits and several times were forced to abandon work entirely for several hours due to a sudden increase in the flow of water.

At elevation -105 rock was reached, the surface cleaned to provide a firm bearing and the first 8 feet of concrete were placed in loosely woven bags, the concrete was mixed rather dry, and three extra bags of cement used per cubic yard of 1:2:4 concrete. During the period of placing the sacks, all pumps were kept in operation and as each bag was thoroughly tamped into place, the flow of water was considerably diminished. Above this elevation the process of depositing the concrete was similar to other under water deposition. Concreting was stopped at elevation -63.7 and as an added precaution a false bell was constructed. The baskets of reinforcing steel were placed and concreting continued to the top of the cylinder.

Foundation Girders

To provide for future subway construction, one row of caissons was left out at each of the various street intersections and the slab column loads are carried by girders to the adjoining caissons.

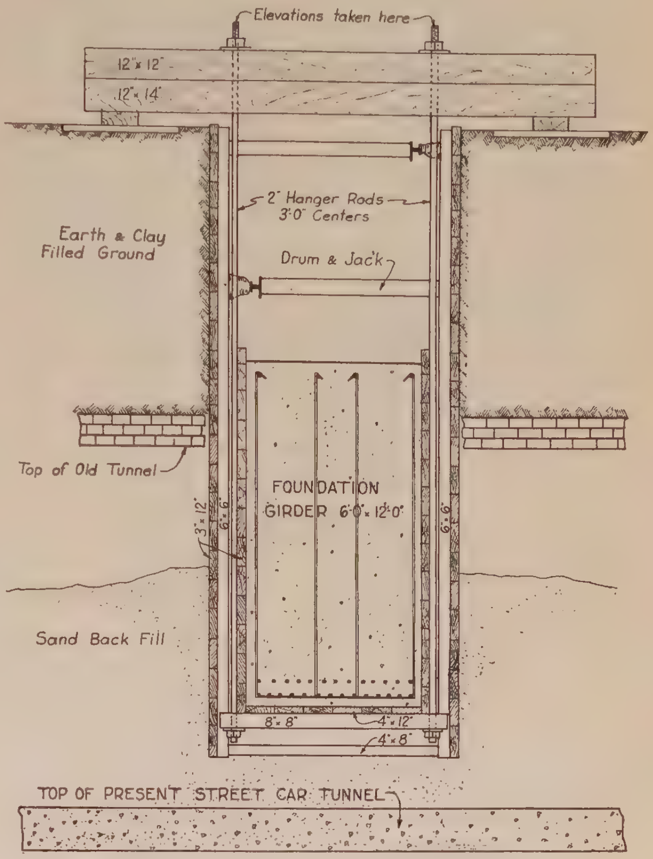
At LaSalle Street a departure from the standard method of building the girders was necessitated. There was already in place a street car tunnel through which the surface lines cross under the river. The present tunnel is a reinforced concrete structure at a somewhat lower elevation than the former brick one and as the intervening space was partially filled with sand and water, the danger of carrying any concentrated load on the roof of the new structure was immediately noted. The elevation of the bottom of the new girders is -16.5, the top of the tunnel approximately -20.0 and the width of the tunnel at this point is 26 feet.

After the excavation was completed, the trench was sheeted and shored, forms were built and suspended from double 12x14-inch timbers above to preclude the possibility of any concentrated load coming on the tunnel roof. As the concrete was deposited in the forms, the attendant settlement of the form work was taken up by the hanger rods, elevations of the top of rods being taken at one-half hour intervals. When final set of the concrete had taken place, a maximum settlement of only ⅜-inch was noted.

Intersection Problem

The uninterrupted service of the street cars at the various intersections presented the most difficult problem. The slab provides a trough for the accommodation of the ballast, ties, and rail, of the surface lines. This trough section was necessarily limited in width by the slab design; the elevation of the street car rail at the bridges was fixed; overhead clearance was already reduced to a minimum by the elevated lines structure above; definite limits for change in grade of the track was fixed due to the construction of the cars; and a flexible, independent structure suitable for re-use at 2 or 3 intersections was desired.

To meet all these conditions and to provide a factor of safety greater than the average construction methods warranted, a temporary street car trestle was supplied. A through plate girder type of economical proportions was eliminated due to clearance lines, and a shallow girder design with floor beams was adopted. Due to the column spacing for the slab, the trestle was built in 32½- and 24-foot sections. The main girders were built up of 4 Ls 4x3x⅝ inches. Webb plate 15½x½-inch, cover plates, top and bottom, 7x½-inch. The maximum moment was 195,900 foot pounds, the maximum unit stress 15,850 pounds per square inch, and a maximum deflection of ¾-inch at the center of the 32½-foot spans when the trestle was fully loaded.



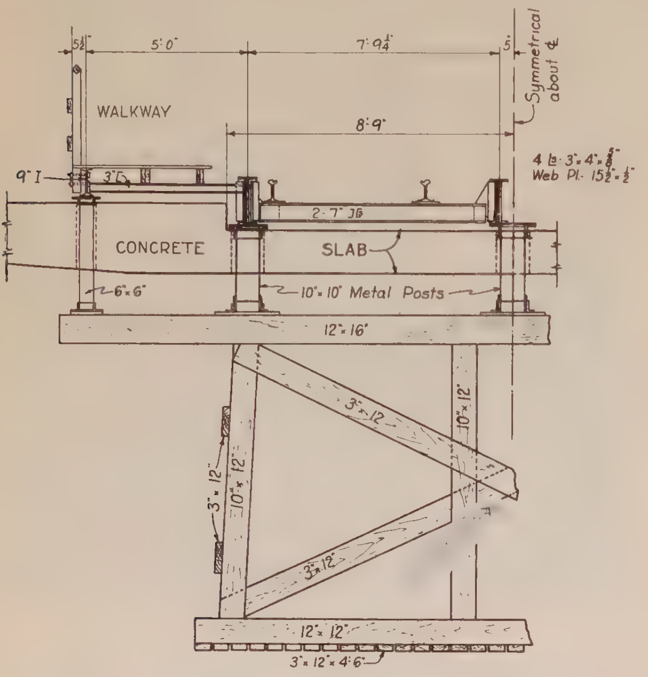
TYPICAL SECTION THROUGH THE SUSPENDED GIRDERS

The floor beams were made up of two 7-inch channels back to back spaced 4 feet ¾-inch centers. The rail used, and to be left in place permanently, was a standard 9-inch No. 130 Loraine Section, fastened to the floor beams by means of standard tie plates and bolts, which on this spacing developed a maximum unit stress in the rail of 8000 pounds per square inch. The girders rested on short built up posts reaching through the slab and necessitating a temporary opening in the concrete of only 11 inches square.

The bearing plate on top of the posts was removable, facilitating the wrecking of the trestle. The posts were carried on temporary timber bents built up from a suitable bearing elevation, depending upon the condition of the subgrade encountered in the field. The outer girders also supported a walkway for pedestrians. All erection connections were made in the field by means of turned bolts, and all parts were interchangeable.

Building Intersections

When an intersection was reached, all traffic was maintained until such a time as the adjoining streets were opened, then all vehicular traffic was stopped. The steam shovels, one on each side of the track, removed as much of the earth as possible without interfering with the street cars. Then the steel work for the temporary trestle was placed along the tracks. Sufficient ties, pavement and other obstructions were removed to slide the floor beams under the track, bolt them to the girders, bolt the rail to the floor beams, and jack the track and trestle up to its temporary position. At a distance of 6 feet on either side of the center line of the temporary timber bents, 12x16-inch timbers were placed and used as supports while the necessary trench excavation for the bents was made. The bents were then framed in place, the track jacked up to temporary grade, the posts set and girders bolted to them, the approach track laid on temporary sand fill, and traffic continued.



TYPICAL HALF ELEVATION OF TEMPORARY STREET CAR TRESTLE

As the only delay to the surface lines came at periods outside the rush hours, their loss of operating time was negligible. Street cars continued to run during the concreting of the slab, the curing period, and up to the time of removal of the trestle. The waterproofing of the trough, and the lowering of the rail to final grade was accomplished between the hours of midnight Saturday and 5 A. M. Monday morning.

The installation of the trestle permitted all construction operations to continue uninterrupted. The girders were built, sewers were laid, column and slab forms erected, reinforcing steel placed, and the concrete placed with a comparatively small extra cost to the contractor, and a minimum of inconvenience to the public.

The care of building and stripping forms, for the slab, drop panels, columns, capitals, etc., made it possible to re-use the lumber as high as 15 times. There was an average re-use of 3 times for all form lumber.

The entire project was in itself unique, in that it is a departure from the standard viaduct structure; that it was built in the heart of a busy business district and completed in a record time. Its completion required the closest co-operation between the engineers and contractors.

The personnel of the Board of Local Improvements in charge of the work was as follows: the late John J. Sloan, President; T. A. Evans, Chief Engineer; Arthur Engh, Assistant Chief Engineer; C. C. Wright, Engineer of Construction.

Supertile Plans and Policies of the MacGlashan Corporation

Announcement was made in the March issue of CONCRETE of the absorption of the Supertile patents by the MacGlashan Corporation, Concrete Division, which is located at Tecumseh, Michigan, and London, Ontario. The policy formulated by this firm regarding relations with its distributors is one of the foremost factors contributing toward its successful establishment.

It is intended to make the product still more widely known. The economic advantage of manufacturing Supertile for the nation's needs with well distributed plants institutes the necessity of the co-operation of numerous manufacturing distributors who will have the advantage of a central force building for a sound business based on dependable production and sales assistance.

The MacGlashan Corporation is leasing the special Supertile equipment. [illegible] is derived through an equitable [illegible] arrangement, which perpetuates an interested direction of Supertile activities. Uniform maintenance of specified standards will be maintained by laboratory check-ups.

Licenses to use the trade mark are granted to those conforming to simple requirements. While the privilege possesses an immediate value, a greater part is potential, since the objective of the MacGlashan Corporation is to render its trade mark of greater national significance, with the product enjoying country-wide demand and good will.

The MacGlashan Corporation is backing Supertile as a big business proposition. All [illegible] have been put into effect for the successful manufacture and marketing of the product and speculative hazards have been studiously eliminated, permitting those appointed as distributors to devote their entire time and efforts to constructive work. Based upon broad patent safeguards, adequate legal protection is assured.

It has been and will continue to be the policy of the MacGlashan Corporation to foster its interests and the interests of those associated with it, through a scientific approach to all facts concerning concrete practices as they relate to products manufacture. To most effectively carry out this policy, a special laboratory at the Tecumseh headquarters is maintained. A constructive program of development, research and check-up work is constantly under way, in co-operation with leading government and private laboratories. It is intended to make this department a specialized Bureau of Standards for the Supertile industry, passing on to each member the knowledge secured.

Bureau of Standards Makes Strength Tests

The Bureau of Standards is carrying on an investigation in which a study is being made of the effects on concrete strength produced by variation in (a) the gradation of the coarse aggregate and (b) the ratio of fine to coarse aggregate when the coarse is deficient in certain sizes. To obtain data from typical aggregates, river sand is combined with three coarse aggregates, gravel, crushed limestone and crushed slag. Cement ground from three different clinkers is being used with all combinations of the aggregates. Standard 6 by 12 inch strength cylinders are being tested at six ages, 1, 3, 7, and 28 days, 3 months and one year. Three proportions, 1:1½:3, 1:2:4, and 1:3:6, are being used with the different aggregates.

In these tests the aim is to obtain the same degree of consistency as judged by experienced operators and measured by means of the flow table and slump cone for each aggregate and each mix.

A Flexible Layout

3,000 Block-per-Day Plant Laid Out Along Simple Lines—Practical Arrangement and Flexible Layout Make for Economical Production—Marketing Methods

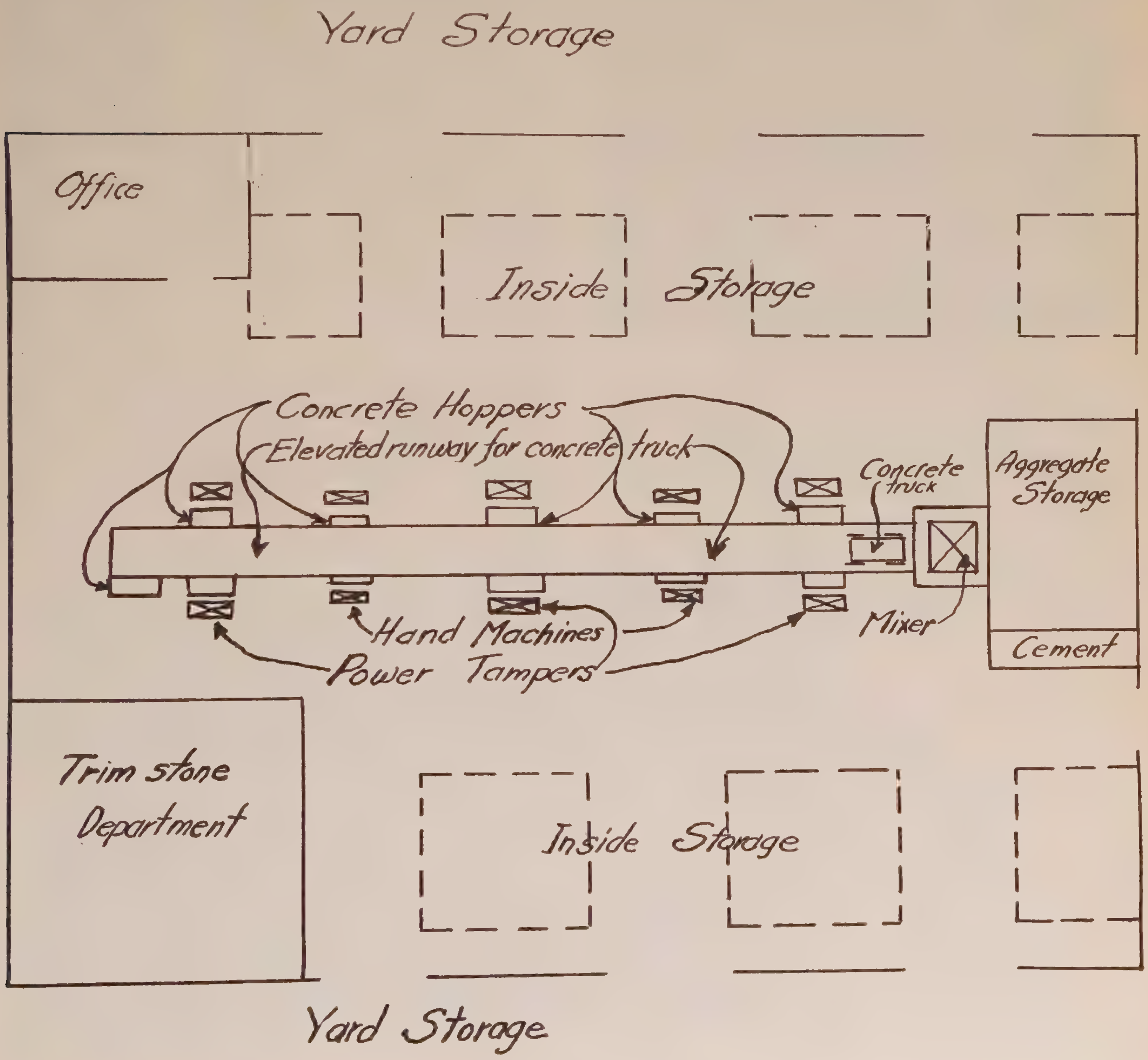
SINCE 1921 the Menefee Art Stone Company at Fort Wayne, Ind., has maintained and sold an average production of 3,000 concrete block per day, in addition to its cast stone production. During that time products plants came and went, price wars raged, and competition was keen, but the trademarked "Menefee Block" stayed on the market. Adequate capital, effective merchandising and low production costs all contributed to the lasting success of the company.

Plant Layout

An accompanying sketch shows the general layout of the plant. Materials are received from a railroad siding at one end of the building. They are placed in storage bins mechanically and fed to the mixer by gravity. A separate storage compartment is provided for cement.

The only mixer in the plant is located on an elevated platform under the material bins. It discharges into a dump car operating on rails on an elevated runway that extends the entire length of the plant. At various locations along this runway and at both sides of it, are the block machines. There are three power tampers on each side of the track. Between these are the hand machines for special shapes, chimney block, etc.

Over each machine is a small hopper into which the concrete is dumped from the car on the runway. An extra



hopper, near the end of the runway, provides concrete for the trim stone department. Only one man is needed to operate the mixer and one man pushes the concrete cart, keeping the machine hoppers supplied with concrete.

After the block leave the machine, they are piled on the floor for inside curing. Here they are kept wet by sprinkling for a period of 4 days. When this period has elapsed, they are taken into the yard for further curing. Between 60,000 and 75,000 block are kept in stock at all times and no block is delivered to the job until it is 30 days old.

A low, flat truck, pulled by a horse, is used to carry the block from inside to outside storage. This arrangement has been found to be very economical and has given entire satisfaction. It requires little investment in equipment and is extremely flexible. Block can be taken from any place desired and put any place in the yard or building.

Merchandising Methods

A considerable portion of the block produced is sold through building material dealers. Six of the largest dealers in the city handle Menefee block. The dealer is given a discount and billed direct. He then becomes the first purchaser of the block and then the seller. Under this arrangement the dealer is entirely responsible for the sale.

The company itself is also in the building material business, handling cement and other building materials except those that compete with concrete products. Opposite the plant is an attractive office and salesroom in which an exhibit of block, trim stone, and garden furniture is maintained.

With the sound business principles adopted and the economical production methods used, the company is able to sell a quality product at a reasonable price with profit.

Foreign Traders from Forty States to Hear Hoover

Foreign traders from forty states will listen at Detroit to an address by Secretary Hoover on May 26th, at the Fourteenth National Foreign Trade Convention, according to O. K. Davis, Secretary. The convention will meet on May 25, 26 and 27, and 2500 foreign traders are expected to attend.

The address of the Secretary of Commerce will be delivered at a special luncheon session, under the auspices of the American Manufacturers' Export Association. Its subject will be "American Foreign Trade," and a nationwide radio audience will listen in to what is expected to be one of the notable business addresses of the year.

Railways Adopt Water-Cement Ratio Law

The American Railway Engineering Association officially adopted a specification for proportioning concrete based on the water-cement ratio law of strength at its annual convention at the Palmer House, Chicago, March 10. This specification was prepared and presented for adoption by the Association's Masonry Committee of which C. C. Westfall, Bridge Engineer of the Illinois Central Railroad, is Chairman, and Job Tuthill, Assistant Chief Engineer of the Pere Marquette Railway, is Vice-Chairman.

The adoption of this specification by the American Railway Engineering Association marks the abandonment of the 1:2:4 and other mixes that have been in use for many years.

New Orleans Adopts Committee Report on Concrete

The new building code of New Orleans, effective January 1, 1927, adopts, by reference, the Report of the Joint Committee on Standard Specifications for Concrete and Reinforced Concrete, dated August 14, 1924. Possible legal objections to the adoption of a specification by reference are overcome by the statement that a copy is on file in the office of the city engineer.

Part XI of the New Orleans code, under the heading "Plain and Reinforced Concrete," consists of two short paragraphs and comprises the entire chapter on reinforced concrete. It reads as follows:

Section 37.—Standard of Practice. Be it further ordained, that all structures, including foundations, of plain or reinforced concrete, shall be designed and constructed in accordance with the details, materials and methods recommended in the Report of Joint Committee on Standard Specifications for Concrete and Reinforced Concrete, dated August 14th, 1924, a copy of said recommendations having been filed in the office of the City Engineer on November 23rd, 1925, and which are now on file therein and by such reference are hereby made a part hereof to the same extent as if herein fully set forth.

Portland Cement. All Portland cement for mortars, plastering and plain and reinforced concrete, shall be of such quality as will meet the requirements of the American Society for Testing Materials, such requirements being a part of the Recommendations of the Joint Committee on Standard Specifications for Concrete and Reinforced Concrete.

Wherever state laws permit this method of adoption by reference certain advantages may be gained by utilizing the privilege. Possible errors and omissions are avoided and the cost of printing the code is considerably reduced.

Court decisions in cases involving the incorporation of nationally-known standard specifications where such specifications are adopted by reference instead of being reprinted, have been quite generally favorable to such adoption. A clear distinction has been drawn, however, between cases where the adopting ordinance referred to the national standard by name only, and cases where both the name and the date of the standard were set forth. Adoption by name only has been held illegal, for the reason that subsequent revision of the standard would automatically bring about a corresponding change in the city's requirements, without legislative action on the part of the city. This has been held to constitute delegation, to others, of the legislative powers of the municipality.

The New Orleans code not only refers to the Joint Committee Report on concrete by both name and date, but specifically refers to a certain official copy of the report as having been placed on file in the office of the City Engineer on a certain date.

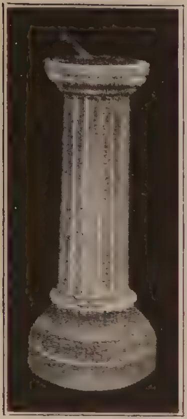
New Jacksonville Engineer Appointed by Association

Mr. H. R. Albion has been appointed District Engineer in charge of the Jacksonville office of the Portland Cement Association. Before entering Association employ in 1926 as a field representative in Florida, Mr. Albion had wide experience in engineering practice, including five years as senior partner of the engineering firm of Albion and Ewing.

How to Make—

Ornamental Concrete Garden Furniture

A Profitable Sideline for Products Manufacturers—Instructions for Making Garden Furniture—Investment Required—Cost—Marketing Methods



THE manufacture of concrete garden furniture is one of the most profitable specialties that a concrete products manufacturer can take on. Ornamental garden furniture units show the greatest percentage of profit of any concrete product.

They are not difficult to make, provided a few simple rules are followed. They do not require a large investment in equipment. Labor cost is comparatively low. And every home owner is a sales prospect.

Among the many items that can properly be considered under this head are: flower pots, flower boxes, urns, vases, lawn benches, sundial pedestals, bird baths, fountains and even tombstones and markers.

The first requisite in the manufacture of ornamental concrete products is quality. Buyers of ornamental concrete demand a quality product. Usually they are people of some means and taste. They buy the products to beautify their home grounds and it is only natural that they should be critical.

The making of these products calls for a high degree of craftsmanship which, in the last analysis is primarily, a knowledge of the subject and care in manufacture.

It is better to make only an average of one piece per day and sell it to a satisfied customer at a fair price than to make more pieces of indifferent quality and sell them at a lower price. Do not sell the products at too low a price. Well made ornamental flower pots should bring from $8 to $30 each, depending upon the design; bird baths from $15 to $30; benches from $20 to $40, etc.

Molds

Most of the garden furniture made in the average products plant is made with the iron molds available from a number of concrete products equipment manufacturers. These molds permit a wide variety of design and are available in several styles for every type of ornamental concrete garden furniture commonly used. With them, the standard designs can be made at a much lower cost

A flower box of special design. Commercial forms are available in a variety of designs for units of this kind

Every home owner is a sales prospect. The desire to beautify the lawn with products like these provides a market in every city than with other molds. Special surface treatments of concrete cast in standard commercial molds will provide further possibilities for variety. These molds are usually well designed and architecturally correct.

Some concrete products men, who make only a few pieces of ornamental garden furniture use wooden molds of their own manufacture. Such molds, if carefully made, will produce a creditable unit, but the labor cost for making the forms is quite high.

A concrete bird bath of simple design

While the market affords a wide range of standard iron molds, there are some cases where special molds are necessary. The making of concrete units of this character comes more properly under a discussion of trim stone manufacture and such special work will be described in a later article.

Wet Cast and Dry Tamp

There are two general methods in use for making concrete garden furniture—the wet cast method and the dry tamp method. Both methods have features that recommend them, and it is largely the personal preferences of the manufacturer and the plant facilities available that determines the method to be used.

In the dry tamp method, the materials should be mixed just wet enough to "ball" in the hand. In the wet cast method, more water is used. The mix should be wet enough to be "spongy."

Forms and other details in manufacture are the same for both methods and any differences in practice between the wet and dry methods will be described when the details of manufacture are discussed.

Proportions

The sections of most garden furniture units are too thin to make it advisable to use two mixes—one for backing and one for facing. On some units, as perhaps some types of lawn benches, the use of two mixes will be found to be economical.

A 1 to 3 mix (one part portland cement to three parts crushed rock) has been found to be very successful for this type of work. It is recommended where only one mix is used for the entire unit and for the facing mix where backing is used.

For simplifying the proportioning of aggregates, they are divided into two classes—fine aggregate and coarse aggregate. Fine aggregates are those which pass through a No. 4 screen, that is a screen of ¼-inch mesh. Coarse aggregates are those which are held on a ¼-inch screen.

When one mix is used for the entire work, one part of cement is combined with 3 parts of fine aggregate. Measuring is done by volume. The fine aggregate for this sort of work should be graded from a 30-mesh sieve size up to ¼-inch. As in all other concrete work, better concrete will result if the aggregates are well graded, that is, if there are about equal amounts of all sizes.

Fine aggregate for garden furniture should be carefully selected because they have an important bearing on the appearance of the unit. Crushed granite or marble of various colors is often used. Then there are a variety of special facing aggregates on the market that give excellent results.

If a backing mixture is used, it is usually composed of one part of cement, 2½ parts of fine aggregate (in this case well graded sand) and four parts of coarse aggregate. The coarse aggregate should consist of well graded particles ranging in size from ¼-inch to ¾-inch. If the backing concrete occupies a considerable volume, particles up to one inch in size are sometimes used.

Placing Concrete in Forms

It is in placing the concrete in the molds that very great care must be exercised. If the dry tamp method is used, the concrete should be fed into the mold a little at a time with constant and thorough ramming. Only by this practice can dry rammed concrete molds be solidly filled and satisfactorily shaped. A badly rammed unit is very unsightly and a direct loss to the manufacturer.

If the wet process is used, the material should be thoroughly spaded to drive out all the air bubbles and to fill every part of the mold.

The forms should be cleaned and oiled each time they are used. It has been found that in oiling forms, only a thin but complete coating of oil is necessary. It can best be applied with an ordinary paint brush, but a piece of waste or cloth will do.

After the concrete has been placed in the molds, it is placed in the curing room. Steam curing, while not necessary, is advisable because it releases the forms so much sooner. If the filled molds are placed in a steam curing room, the molds can be removed in 24 hours. If they are only air cured, the molds of a wet cast unit should not be removed before 48 hours have elapsed. Steam cured units can be pointed up and defects repaired on the second day, washed the third day and shipped the fourth day, though it is well to cure them for a little longer period. If steam curing is not used, it is advisable to cure the unit for at least a week before shipping it.

Surface Finishes

A great variety of surface finishes are possible. For the exposed aggregate type of finish, the mortar of the finishing coat should be composed of selected coarse sand, crushed marble, granite or other special facing material. If a pure white surface is desired, white cement should be used.

Some pleasing surface finishes may be made by using selected colored aggregates in the facing. White marble chips with a sprinkling of black marble or green-black copper slag gives a surface, when properly treated, resembling a natural marble. Buff pigment and graded marble chips with a sprinkling of mica spar produces a surface similar to limestone. Prepared special aggregates of this nature are available on the market.

After the molds have been removed, all slight defects in the unit should be repaired. To expose the aggregate and secure the surface effect desired, it is necessary to etch the unit with acid to remove the film of mortar on the surface. This operation also has the very important effect of tending to prevent the formation of the tiny hair checks usually called crazing.

The acid solution to be used is composed of one part muriatic acid to four parts of water. If it is possible to do so, it is better to have enough of this solution in a tank large enough to permit the entire unit to be immersed. The acid will then etch away the mortar and it will be necessary to brush only those spots having an unusually heavy coating of mortar.

If the use of such a large tank is impracticable, the same result can be obtained by washing the surface with the same solution and brushing it thoroughly with stiff bristle brushes that have been immersed in the acid. This method, while just as effective, involves more time and labor than would be needed if a tank were used.

Merchandising Ornamental Concrete

One of the outstanding reasons why many concrete products men have failed to make the garden furniture end of their business a distinct success is lack of merchandising. As a rule, the product is not actively pushed. Concrete garden furniture cannot be sold in volume by merely making the units and then holding them in the shop in the hope that some one will come and ask for them.

There are several methods of merchandising that have proved very successful for ornamental concrete garden furniture. They include the use of folders distributed by mail, house to house canvassing and selling through the department and furniture stores.

Naturally one of the first requirements in selling any product is to get out a printed and illustrated leaflet describing your wares. Such a leaflet should contain illustrations of the various units with information as to the size of each unit and the cost. In another section of the folder it might be well to say something of the manufacturing process and a discussion of why concrete garden furniture is desirable. Some very attractive booklets have been gotten out by products manufacturers on this line.

Such leaflets or booklet "catalogues" can be sent by mail to a list of home owners. The only equipment necessary is a supply of the booklets. If they are available, a number of attractive photographs showing the furniture on the lawn, would be good sales helps.

The next thing is to choose a number of high school students who want to earn a little extra money. These students go from house to house to get orders and to leave the booklets. They collect whatever their commission is as a down payment, and the units are then delivered C. O. D. for the balance.

Another method that has brought good results is merchandising through department stores and furniture stores. It is natural that when people think of buying garden furniture they inquire for it at the furniture or department store. The products manufacturer sends some samples for display at the store, supplies the store with a number of his booklets and pays the store a discount on every sale.

It is not necessary for the store to stock the furniture or to deliver. When a sale is made, the order is telephoned to the products manufacturer and delivery is made direct from the plant.

Department stores are usually glad to make such arrangements and they have been very successful in selling the units. Such nationally known stores as Marshall Field in Chicago and Wanamaker in New York have sold many units of concrete garden furniture under arrangements similar to those described.

Some of the larger manufacturers ship their products over a large area. All plants can economically ship this type of unit within a radius of from 30 to 50 miles. When garden furniture is shipped, it is necessary to crate it carefully after it has been packed in excelsior or straw.

There is a market for concrete garden furniture in every city. Pride in the appearance of the home grounds is a strong sales incentive. Usually it is the women who buy the greatest number of these products.

Bird baths, flower pots, flower boxes and benches are the best sellers. There is also a big field in selling flower pots for cemetery use. The manufacturer can put a name on the base of the flower pot and it will serve as a monument.

Investment Necessary

It is possible to start manufacturing concrete garden furniture with an investment as low as from $300 to $500 for molds. It is well to start with a fair variety, say four or five designs of flower pots, two or three of bird baths, two or three of flower boxes and two or three of lawn benches. As the demand for the product grows, additional molds can be bought. It is well to feel out the market first to see which designs and which units are in greatest demand.

In most products plants one of the steadily employed men can be trained to make this specialty. One man can mix the concrete, make the unit and point and etch from 8 to 10 pieces per day, if there are enough molds available in the shop.

Ornamental flower pots are in great demand

Confining Useless City Streams in Concrete Channels

By Putting Such Streams in Underground Channels, Public Nuisances Are Avoided—Some Examples—Types of Channels Used

A STREAM running through a city is a public nuisance at the best. If it is not navigable it is a total waste unless by chance it is utilized in the development of park grounds. Many such streams have been put in concrete "strait-jackets" with infinite benefit to the city.

Consider a stream that is not navigable and is not utilized in a scheme of park development. It is likely to be a dumping ground, known sometimes as a bone-yard, detrimental to the health of the community. Its appearance is harmful to adjacent property values on each side of the stream. It brings on frequent floods, causing property damage. It is a constant hindrance to traffic, even at bridges. It compels the city to build and maintain a number of bridges. It breaks the continuity of many streets. It blocks normal growth in certain directions. It destroys, for all practical purposes, a strip of ground several hundred feet wide, especially if the stream flows in a deep gulley. If the stream is sluggish it serves as a breeding place for mosquitoes.

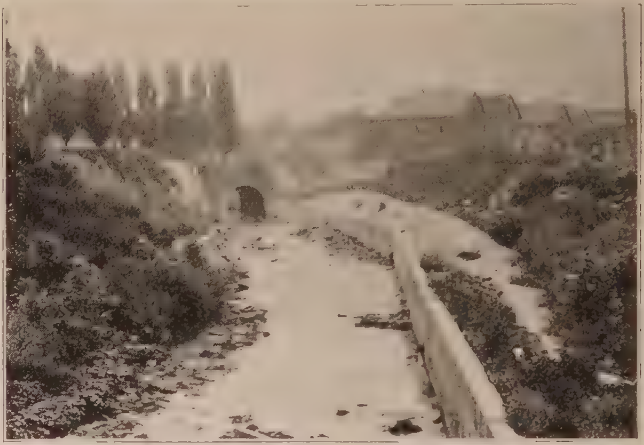
Such a stream can be eliminated completely, not by dredging a new channel around the city, but by placing it into an underground concrete strait-jacket, levelling off the ground above it and using to better advantage the strip of property formerly occupied by the stream. All bridges can be dispensed with, at a great saving to the city. Floods will be a thing of the past. Streets may be built over the stream the same as elsewhere. Property values will rise to the level of other property in the same section. Buildings may line both sides of the streets crossing the stream, as if no stream existed, for in reality what was formerly a troublesome, crooked and unsightly creek is now flowing unnoticed through a tube many feet below the surface.

Elimination of Mill Creek

A typical stream of this kind was Mill Creek, in Erie, Pa. That stream, of which a view was taken in 1919 as shown in an accompanying illustration, was for many years considered a public nuisance. Each year it was the cause of destructive floods, due to the steep slope of the stream bed and the rocky nature of the drainage area, which produced a high rate of run-off. The drainage area contains only 13 square miles, but the sources of the stream are from 500 to 750 feet higher than the outlet into Erie Harbor, and at the entrance to the southern limits of the city the stream bed is 170 feet above the mouth. The slope through the city averages 1.2 feet of drop per 100 feet of distance. This combination of rocky surface and steep slope produced sudden and violent floods which carried large quantities of debris along with the water, clogging the channel at bridges and at bends in the stream.

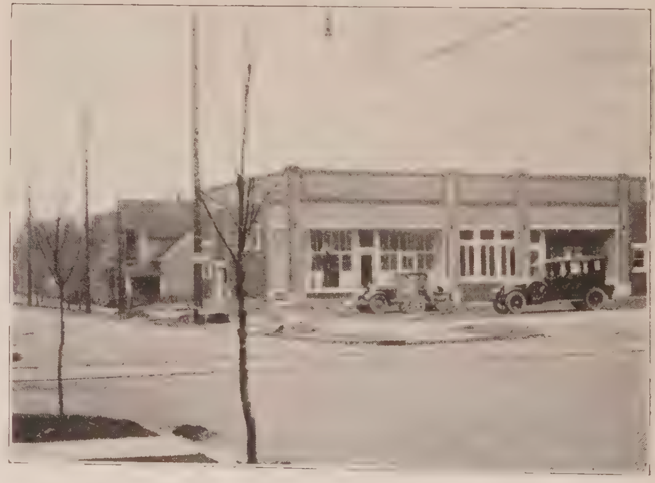
A flood of August 3, 1915, was the most destructive of all. It caused the loss of several lives and property losses to the extent of several million dollars.

The ultimate result was that by 1921 Mill Creek had been placed into a reinforced concrete strait-jacket consisting of an elliptical tube having an inside vertical dimension of 18 feet and a horizontal dimension of 22 feet. The total length of the tube is about 14,000 feet, or nearly three miles. At the southern end of the tube near the point where the stream enters the city limits, a large deflector was built to prevent driftwood from entering. The deflector serves also as a bridge between two sections of Glenwood Park. A special intake also was built at the head of the tube. The entire cost of the work at Erie was about $2,200,000.



Mill Creek, Erie, Pa., in 1919, before construction work was started, was typical of the unsatisfactory conditions common to open streams in cities

The construction of the tube has brought about a decided improvement in the physical appearance of the entire Mill Creek district, a fact that is well illustrated in two identical views shown herewith, one from a photograph taken in June, 1920, while construction was under way, and the other taken at the same point, and looking



The same location in 1926, after the creek was confined in a reinforced concrete tube under the surface in the same direction, in December, 1926. These pictures were taken at what is now the intersection of Sixth and German Streets, looking northeast. In both instances the camera was pointed down the center line of the stream. The tube through which the stream now is flowing passes underneath the new garage building shown in the later picture at the northeast corner of the street intersection.

Showing the construction of the reinforced concrete tube in the bed of Mill Creek

The increased property values resulting from the transformation of the Mill Creek district were taken into account in the readjustment of values for taxation purposes. Total valuation increases amounted to $300,660, offset by $30,420 in damages allowed. The former figure falls far short of the actual increase in value of property along the stream. The entire cost of construction was paid out of the general funds of the city, no special assessments having been levied against the property most directly benefited. The taxpayers of the city, however, do obtain a direct benefit through the removal of a number of bridges and the consequent elimination of the cost of their maintenance and renewal.

Scajaquada Creek, in Buffalo

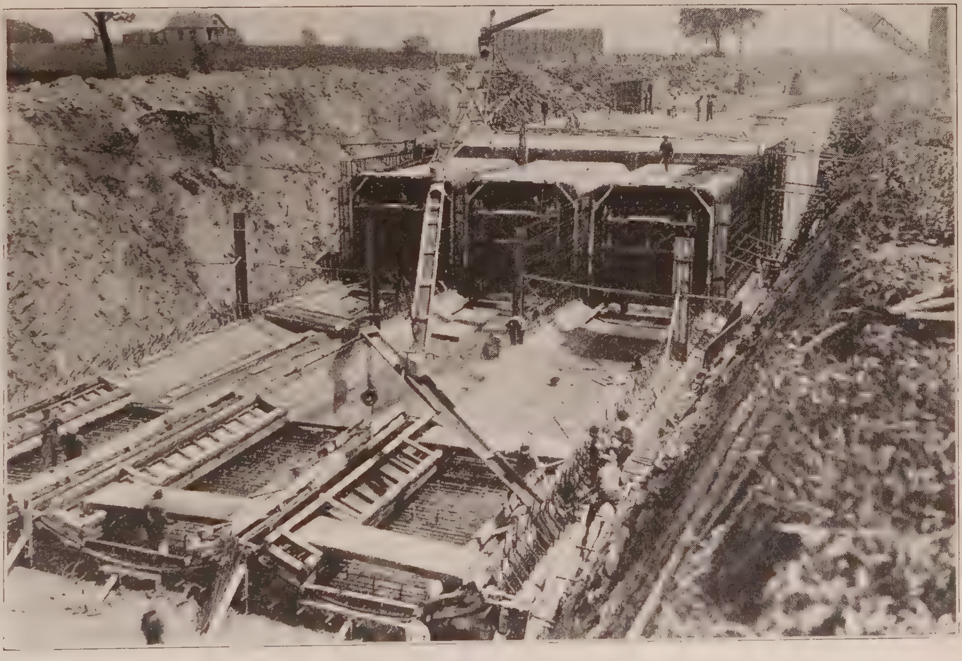
In Buffalo several sections of a stream known as Scajaquada Creek have been placed in an underground reinforced concrete tube, which has vertical side walls and an arch overhead. The width of the tube at the outlet is 33 feet and the height at the center is about 14 feet. All bridges formerly built and maintained along this part of the stream were eliminated. This item alone will mean a large saving. The stream runs through the northern section of the city and a part of it was utilized years ago in the development of Delaware Park. This stretch is left undisturbed. The remaining length of the stream, lying within the city limits, both above and below the park section, will be completely removed from sight when the work is finished. The first section, a stretch of 6,022 feet, was built in 1922. The second section, 7,200 feet long, was built in 1924. The total length of the conduit eventually to be built is 15,380 feet, so that only about 2,000 feet of the length remains to be completed. The total drainage area of Scajaquada Creek is 24 square miles, and the run-off at times exceeds 1,000 cubic feet per second. The capacity of the concrete tube, however, greatly exceeds this amount.

Stream Now a Storm Sewer

Armstrong Creek, in Peru, Indiana, was eliminated from a residential section of that city some 20 or 25 years ago through the construction of an underground arched reinforced concrete tube, 8 feet wide and 6½ feet high at the center. This is, in fact, the earliest undertaking of this kind which is recorded. The entire tunnel has been covered over with earth and the residential streets crossing it are in no way affected by the presence of the stream. The tunnel is in fact now serving as a main storm sewer. This work cost only about $16,000; but that low figure was obtained in pre-war days.

Connors Creek Tube, Detroit

A much larger storm sewer than the one just described is the triple tube of reinforced concrete that now occupies the former channel of Connors Creek, in Detroit, a stream with a drainage of 41 square miles. One of the illustrations shows this work under construction. The first sec-



Connors Creek sewer, Detroit, Mich. This reinforced concrete triple tube occupies the former bed of the creek. One section is 7,770 feet long. The cost was $285 per linear foot tion, a length of 7,770 feet, was built in 1922 at a cost of $2,190,000. Each of the sections of the triple tube is about 16 feet wide and about 18 feet high. This underground channel, now one of the main arteries of the reconstructed storm-sewer system of Detroit, was described and illustrated in considerable detail in the October (1921) issue of CONCRETE.

Stream Now a Boulevard

A stream known as Jones' Falls Creek formerly ran through the very heart of the business district of Baltimore. It still flows along the same route, but for a distance of nearly 7,000 feet in the down-town district it is confined within a triple reinforced concrete tube. This work, begun in 1911, was completed in 1915, and a wide boulevard known as Falls Way, built above the concrete tube, now utilizes the visible space formerly occupied by an unsightly stream.

Open Channel Method in Syracuse

Onondaga Creek, in Syracuse, N. Y., was diverted into a straight open-topped concrete channel in 1920. While open-topped construction is less expensive than a covered tube, the trouble with the open channel is that the city must continue to build and maintain bridges across it. Consequently it is very doubtful that there is an actual saving of money through omission of the cover. Furthermore, the open channel is certain to be more or less unsightly, and during low stages of water it may be a breeding place for mosquitoes.

Onondaga Creek development, Syracuse, N. Y., an open concrete channel with sloping sides

Three Streams Eliminated in Lebanon

In Lebanon, Pa., during 1918 and 1919, the city undertook the straightening out of three streams, namely, Quittapahilla Creek, with a drainage area of 7 square miles, Hazel Dyke Channel, with a drainage area of 8.5 square miles, the Brandywine Creek, with a drainage area of 3.8 square miles. Here, as in Syracuse, the streams were not covered over, but were placed into channels having concrete floors and reinforced concrete side walls, in the nature of retaining walls. As in Syracuse, these straight, open channels occupy much less width than the former streams occupied, they permit a rapid flow of flood waters and prevent overflow; but they are not pleasant to look at, nor do they permit the elimination of bridges. A short stretch of 800 feet over Hazel Dyke Channel was covered with reinforced concrete slabs. The top slab of a part of this covered stretch is also the east sidewalk of Twelfth Street.

The channel for the third stream, Brandywine Creek, is of a similar nature as the other two, with a concrete floor slab and reinforced concrete side walls acting as retaining walls. This channel is utilized also as the outlet for a large intercepting storm sewer. In fact the three channels were directly connected up with a new storm sewer system for the entire city. The storm sewer system had suffered from neglect quite as much as the streams themselves. This plan to make the stream channels a part of the sewer system helped materially in bringing about a favorable vote on the bond issue required to carry out the plan.

The Most Satisfactory Method

The most practical and thorough method of getting rid of a stream in a city is to put it completely underground, connect it up with the storm sewer system so that it will serve as a main artery of the system, level off and improve the property above and along it, and require the owners of this improved property to pay special assessments to cover a part of the cost. This will in most instances be an equitable and satisfactory method and in the end it may be the most economical.

Placing Concrete Under Difficult Conditions

The accompanying illustration shows a 1,750,000-barrel concrete oil reservoir being constructed by the Robinson-Roberts Company for the General Petroleum Company, Watson, California.

Exceptionally good results were secured on this job. The concrete was placed with a minimum of labor and set up with a finish of excellent texture and uniformity. Placing the concrete at the sides of the tank (slope 1½:1) would normally have been a difficult operation and one which could not be satisfactorily performed without using a considerable excess of water. A relatively dry consistency was used on this part of the work. Three pounds of Celite per bag of cement was used as an admixture. This reduced the amount of segregation and resulted in a uniform concrete.

Method of placing concrete on a 1½ to 1 slope

The mix was 1:2:4; a total of 5100 cu. yds. being required.

Concrete
in
Architecture

Entrance detail of the all concrete high school at Healdsburg, Calif. Wm. H. Weeks, architect.

AT the recent convention of the American Concrete Institute in Chicago, an entire session was devoted to a discussion of the place of concrete in architecture. More than 75 members of the Illinois Chapter of the American Institute of Architects attended.

Three papers were read by nationally famous architects in which the artistic and structural possibilities of concrete as an architectural medium were analyzed. Abstracts of these papers are presented on the following pages.

It is significant that all of the speakers stressed the need of treating concrete frankly as a new construction medium instead of using it as an imitation of some other, older building material.

The importance of the concrete form was also forcibly brought out. The completed structure will inevitably be only what the form permits it to be.

The Architectural Uses of Concrete

(With Incidental Reference to Cement, the Tie that Binds)

By **IRVING K. POND, C. E., F. A. I. A.**

I AM frank to say that I shall deal now, as I dealt in a previous paper, in great measure in generalities, leaving the specialists to deal with details both as to manufacture and application. Basic in all design and construction, and in the application of methods and materials, are broad general principles which should be understood and acted upon if there is to be a permanent advance in the building arts. It is with one or more of these principles that I am concerned in this paper which will touch upon details only as they may be made to clarify the general proposition.

The material which acts as a cohesive and binding element in this organization, the material which is common to all the products the manufacture and application of which brings this body together, is cement. With cement as a binder, the choice of an infinite number of other

Miami-Biltmore Hotel, Coral Gables, Fla., an 11-story reinforced concrete structure. The exterior is finished in portland cement stucco.

materials is presented to form what is known as the aggregate; so that according to the will of the producer, bodies hard, soft, smooth, rough, in monotone or rich in color, pervious or impervious to moisture, defiant of the action of fire or of frost, are forthcoming for employment in structures of a wide variety of use and beauty. Cement materials thus produced form the basis, according to the required characteristics, of structure, of exterior, or of interior walls, of floors, of ceilings, structural or ornamental, either or both. The field would seem limitless.

With all this seemingly infinite variety in use and potentiality one would think that there might come some originality of expression; one would expect something intrinsic in the material itself, something of an inner nature, which might be demonstrated upon the surface; something so *sui generis* that even a designer with but a superficial mental and spiritual equipment would hesitate to use it in imitation of other materials, or to leave the marks of other materials upon its surface. The possibilities of texture, the possibilities of color inherent in the product make it a thing through which the sensitive designer can make his feelings flow—so that to have this product made the medium of a wonderfully expressive art all we would seem to need is a wonderfully sensitive designer!

Methods of Use

There are two methods of introducing concrete into structure; one is by setting precast units, as stone is set, and the other is by casting the material in semi-liquid form into moulds which characterize and define the form. The first method may be enlarged upon to a degree and in a manner to put it away beyond the simple placing of structural unit upon structural unit.

The other method is by casting the concrete in forms. Those forms are preconceived forms emanating from the hand and brain of man.

So we come face to face with a fundamental abstraction, a fundamental proposition of life. Life feeds upon life; beauty feeds upon beauty. There can be no life unless life is given to it; there can be no beauty unless beauty be sacrificed in the making. The masonry arch which spans in airy grace the rushing torrent was built upon a centering which was just as beautiful in its own way and in its own way just as much a work of art, but which had to be destroyed that the arch of stone might function. Even more so does this proposition hold with concrete structures which are to function for use and beauty. If the concrete product is to be perfect the forms must be destroyed. That which was in itself perfect must be destroyed that ultimate and permanent perfection may be achieved.

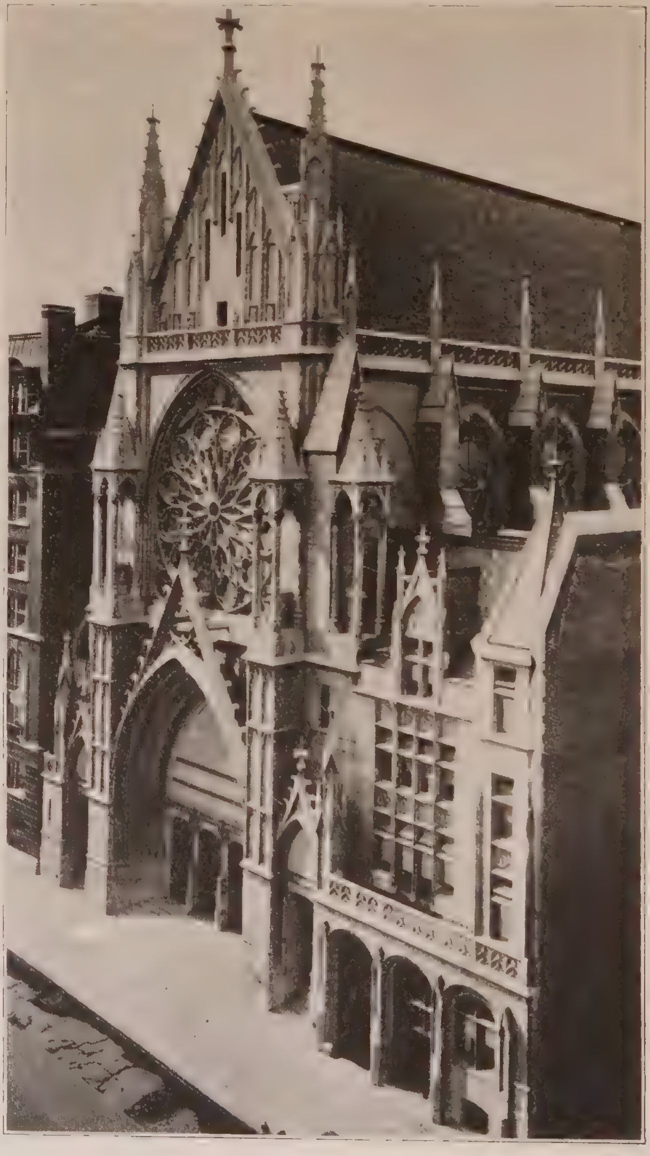
Form Craftsmanship

Leaving out of account the dreary hours of toil and drudgery in forests and mines and over weary trails that materials in the rough may be at hand, note a few of the elements of artistic craftsmanship which, only to be lost to the sight and knowledge of the general observer, must enter in that the exposed concrete of the structure may be a finished product—carpentry and cabinet making, metal working and modeling. Each of these is accompanied by work in other trades. To my way of thinking it takes a deal of moral stamina for a carpenter or a craftsman in wood, or for a sculptor working in the clay, to carry out conscientiously a piece of work which he knows is to be destroyed that some other material may come to exist in perfection of form—that his work must be lost that some other may come into being.

The designer in concrete must be made to realize, if he does not, how much he owes to other arts and crafts and consequently how much he owes it to himself to treat material for which he is designing with respect and bring out its intrinsic potentialities to the best of his ability. He is not doing this if either in surface treatment or in structural form he imitates the characteristics of another material. If concrete is to be used it must be treated on its merits and handled with respect.

We have, in this country, developed a wide variety of textures and surfaces which may be applied to walls to make them look like concrete, though the background may be flimsy lath or clumsy bats of brick. We have in small measure as yet developed the constructional side as has been done in other lands, particularly in Germany and France. Our structures, outside of certain massive engineering works, have been confined to post and beam types, though arcuated structures are in evidence. But we have not spanned great spaces with structural vaults and ribs which take of themselves pleasing forms while following and containing the paths of structural forces, as has been done abroad.

This is a field in which the structural imagination may well be allowed to play; a field in which our designers, with their material instinct for bigness and spiritual instinct for simplicity, should be eminently successful.



Precast concrete units. The Church of the Blessed Sacrament, New York City. Gustave E. Stineback, architect

Unadorned monolithic concrete walls feature the interior of St. John's Episcopal Church in Los Angeles

The Architectural Theory of Concrete Design

By FREDERICK L. ACKERMAN

CONCRETE is not a new material in the world of building. Indeed, it is a material of great antiquity. But the conditions under which it is now employed, the technology of its use under the strict guidance of scientific insight and knowledge, shifts it over definitely into the category of something new. We may well pause for a moment and consider the significance of this change.

When a new material, device or process takes definite shape out of our experimental fumblings, there follows, particularly when the invention is of a revolutionary character, a long train of blundering effort in our attempt at adoption, use and development. The act of discovery and invention does not set us free: Our habits and preconceptions bind us to our old techniques and applications.

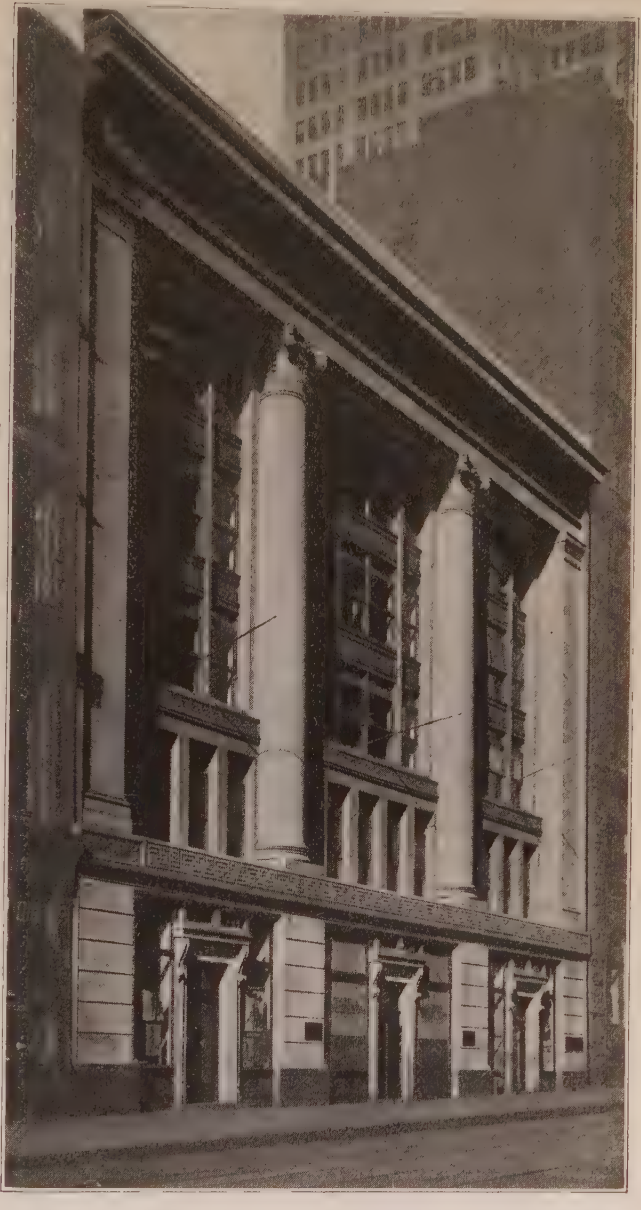
The use of this new material is now seriously hampered by the condition that the present objective with respect to its use centers in the utilization of it as a substitute. Designers of concrete are as yet handicapped by what has gone before.

Field for Concrete Grows

I have referred to concrete as a new building material. What serves to place it in a category by itself is the comparatively recent expansion of its structural functions. This expansion of functions was due to the application of science. I refer to the multitude of structural uses to which it is now put. No longer is its use confined to weight bearing. It now serves in tension as well as compression. Not only walls and piers but beams, girders, slabs, arches and vaults are all rational expressions of its properties.

This is, of course, but to state the obvious. But it may be worth while to emphasize it. For during the early phases of development, those engaged in experiments and those intimately associated with the use of an invention, a new material or process, are not likely to appreciate fully the significance of what they do as a matter of course.

The introduction of a single material that will serve a wide range of uses hitherto served by a variety of materials is significant from the standpoint of architectural expression. For it constitutes no less than the foundation of a revolutionary change in design.



Artificial stone was used for the street front of the Gaston, Williams & Wigmore Building in downtown New York

The theory of concrete design revolves itself immediately into a theory of building the preparatory structure, the form. The preparatory structure—the form—is the beginning and the end of concrete design.

In concrete we are dealing with a plastic material. But its use differs from that of clay in that it serves our structural and architectural ends only when it is rigidly confined within a preparatory structure—the form.

Development Gradual

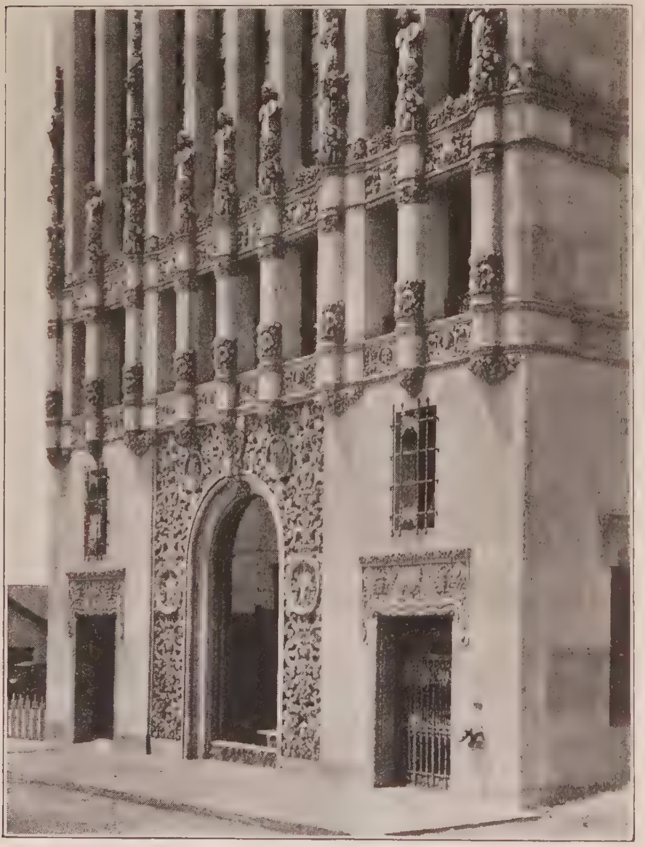
A new architectural expression of a revolutionary character cannot be generated at will. There must be, apparently, if we may draw upon the history of industry, a period of experimental work—a period of transition. And the outcome depends, not so much upon the potentialities of the case as it does upon the thought that guides exploration and creates definite aims.

Without going into the details of form building we may mention a few of the steps which would constitute a rational procedure. By secondary forms built into the angles of our preparatory structure we may produce champfers of endless variety and detail. Thus the silhouette of piers may be modified and shaped to our aims. In the same way the enrichment of openings—doors, windows, rectangular and arched—may be secured. These secondary forms in no wise complicate the construction of our primary form; nor do they weaken it. They strengthen the form and at the same time eliminate the sharp arrisses from the structure.

The simple planes of our primary form lend themselves to endless modification by the application of secondary forms which will appear in the finished structure as incised lines, sunken panels, plain or molded. Again these in no wise weaken or complicate the building of the primary form which remains undisturbed. Nor need we stop with the introduction of champfers, lines and panels. Still working within our form we may proceed to the treatment, in intaglio, of the secondary planes and even lines and champfers.

Precast Units

No reference has been made to the use of concrete cast in forms prior to placement in the building. So far as concerns the effect and hence, so far as concerns design, it can make but slight difference whether the material used be stone or cast concrete. Shapes and dimensions of individual pieces might differ; and what has already been said of form building would apply with some force to the preparation of forms for individual blocks of concrete. But even so, a theory of an architecture rendered in precast concrete would differ in no material way from the theory of an architecture rendered in stone. For the technique of erection would be essentially the same in either case.



Concrete trim stone and portland cement stucco were used to ornament the warehouse of the Hollywood Storage Co., in Los Angeles

The Anson Mills office building in El Paso, Texas, a reinforced concrete building with a cast stone exterior

The Use of Concrete on the Pacific Coast

Its Structural and Aesthetic Possibilities

By JOHN C. AUSTIN

WE all know that various kinds of concrete have been employed for centuries, and that many examples may be found in different parts of the world today that conclusively prove the ancients well understood its use and its great value, but within certain limitations. Its growth and rapid development in this country may be said to date back about a generation or so and, during that period, the tremendous strides it has made, in nearly every direction, render it nothing short of phenomenal, warranting the prediction that, in course of time, it is destined to become a "universal" medium of structural expression.

The practicability of its use even in the construction of buildings of great height, is splendidly demonstrated in the 17-story "Ingalls Building," erected at Cincinnati in 1903, and for many years the "tallest concrete office building" in the country. It was regarded, at the time, as a very daring undertaking, and there were many architects, as well as engineers, who were skeptical of its success.

Use on the Pacific Coast

Here we are concerned with the use of concrete on the Pacific Coast; and a tour of inspection from Seattle on the north to San Diego on the south will convince the most skeptical that reinforced concrete has come to be regarded as one of the best materials to be employed in the construction of safe and fire-resisting buildings.

Owing to our increased knowledge and improved technique of structural design, particularly with reference to fixed frames, arches and general problems dealing with continuity and monolithic conditions, together with the general increased efficiency and control of concrete production, the adaptability and use of reinforced concrete as a strong and economical structural and architectural medium, is rapidly increasing and gradually tending towards the development of a new architectural style.

A great deal of the heretofore laborious mathematical work, involved in its design, is gradually being eliminated while shorter and more practical methods of calculation are coming into vogue and, to a large extent, being standardized.

The simplication of the methods of design has tended toward the establishment of more confidence and a broader, clearer conception and knowledge of the properties of reinforced concrete which, in the last analysis, means that this type of structure will henceforth be more efficiently and economically designed.

The use of the principles of the arch, particularly in reinforced concrete, should be exceptionally well adapted to our structures. It is an established fact that, generally speaking, no more than 37½ per cent of the concrete in a straight beam or girder is figured to resist compression, whereas close to 100 per cent of the concrete in an arch is usually effective in resisting compressive stresses. The arch is one of our most economical structural units and its use architecturally is legend.

Structural Possibilities

From an engineering standpoint, the structural possibilities of reinforced concrete are practically without limit. Cantilevered footings along property lines permit occupancy of the full width of a lot without encroaching on adjoining property.

General alterations and revisions in plans during the construction of reinforced concrete can be made more economically and expeditiously, as compared to equivalent changes in steel construction, wherein detailing and fabrication play so important a part.

Now, as to the aesthetic possibilities of concrete, it must be very manifest, even to the casual observer, that the volume and variety of the uses of reinforced concrete have been steadily increasing and its ready adaptability to the production of architectural effects in buildings, aspiring to the more highly developed character, are just beginning to be appreciated.

Heretofore, many architects have assumed that, if a building is really to aspire to any degree of importance architecturally, it must exhibit a veneer of a permanently superior nature, such as characterizes granite, stone, marble, terra cotta, etc.

That this is a fallacy is effectively demonstrated by the fact that, in the rapidly growing city of Los Angeles, there are a number of very progressive architects who are ardent advocates, even champions, of the more general employment of reinforced concrete for all types of buildings, including dwellings; and they have produced many unusual, remarkably beautiful and charming examples of a variety of types.

Color treatment of concrete surfaces is a comparatively new art, which promises wonderful possibilities and may be divided as follows:

Color materials mixed with the aggregates; surface treatments, such as acid staining, applied oils or stains, and abrasive treatment, by tooling, to bring out the colors in the stone or gravel.

Stucco or plastered finishes, such as neat cement washes, application of patented stuccos, such as California colored plasters, Scrafito and the cement gun. Inserts for monolithic casting, such as colored tiles, marbles and other decorative materials.

No Longer Disguised

Today concrete is emerging from its era of disguise and concealment. Just why it was so long treated as something to be ashamed of is difficult to explain. When it attained structural reliability it became as respectable a material as any other, and it held a wonderful capacity for varied and attractive treatment. Yet for years designers concealed it expensively or dressed it like cut stone to the deception of none but the near-sighted. Its finish was but little less foolish than the "Tin Ashlar" that once adorned the edifices raised by ambitious citizens of western boom towns.

Like the solid rock and the granite and sandstones of the Nile, concrete will, in due course of time, be shaped, formed and colored to meet the aesthetic requirements of the age in which it plays so important a part.

Concrete Tests Successful

Results of tests of a new method of reinforcing and repairing structural steel with concrete, recently made in the engineering department experiment station, Ohio State University, Columbus, Ohio, not only have exceeded all expectations, but may show the way to a new era in structural steel engineering, experts at the university have reported.

This was made known in a preliminary report on the results of the tests by Professors Clyde T. Morris and J. R. Shank, of the university's civil engineering faculty, who had charge of the experiments.

The new method, devised by Clement C. Cooke, former Ohio State student and a member of the 1922 American Olympic teams, consists in applying a special kind of concrete under high pressure on steel beams.

Besides proving that the old steel and the special concrete reinforcement act together practically as a unified material, the tests indicated these possibilities:

Steel beams, given the special concrete treatment, can be made to carry far more than the load of the original beams.

Condemned and weakened beams, so treated, can be made stronger than they originally were.

Viaducts and bridges can be repaired or strengthened simply by applying the concrete.

Such repairs or strengthening can be made in much shorter time than heretofore, with a consequent economy of time and expense and a minimum interference with traffic.

One 24-inch I-beam, seven days after being reinforced by the Cooke method, was estimated to be able to carry a load of 235,000 pounds. When tested, however, it bore 333,000 pounds, or more than 40 per cent greater than the estimate.

It is possible, under this new method, Professors Morris and Shank report, to repair a weakened bridge or viaduct in place at much reduced expense and in a much shorter time than heretofore.

New Equipment

Hawley Strips for Tying Forms Efficient

For tying concrete forms, the Hawley Tie Bolt Company, Minneapolis, Minnesota, has placed on the market Hawley Strips. A length of strip equal to the wall thickness, with enough surplus to wrap around the upright and waling on two sides, is cut off, and flattened with the hammer where the form boards come together. It is then bent around the upright and nailed securely, and is easily removed with tinner's snips.

Contractor Finds Many Uses For New Chisel

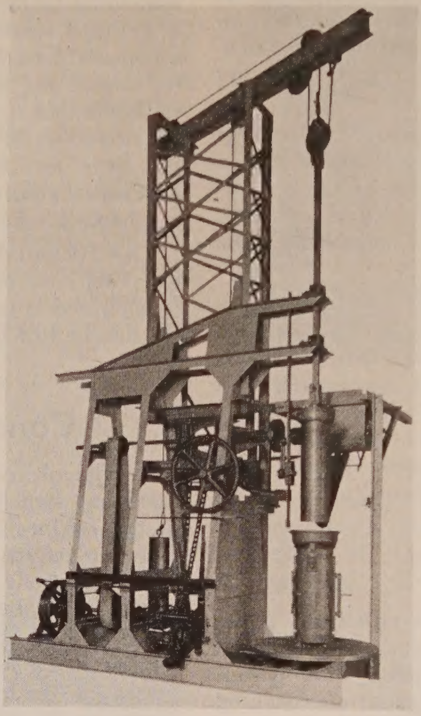
The contractor will find many uses for a new chisel being produced by the Gifford Wood Company, Hudson, New York, manufacturers of elevating and conveying equipment.

The blade is ground to a thin cutting edge to wedge easily and prevent breaking the lumber. It may be sharpened from time to time. The shank is made of a special analysis steel to provide maximum stiffness in prying. The long shank adds necessary leverage for heavy work and may be used to reach in deep places to cut reinforcing wire or nails.

The chisel is also useful in cutting heavy clay in foundation work, chopping post holes, removing shingles or old lathes and plaster and in numberless odd jobs it is indispensable. In prying the thin edge provides the "bite" between close fitting timbers where a crowbar will not enter.

Entirely New Pipe Machine Shows Thoughtful Design

Its simple operation is one of the most favorable features of the Easterday pipe machine, manufactured by the Phil Easterday Company, Terre Haute, Indiana. Operating levers are conveniently arranged and provision is made for attaching the motor directly on the machine.



The experience gained in eighteen years of pipe manufacturing has been put to use in the design of this pipe machine. Construction is such that the three units may be dismantled without any adjustment of working parts. A low room can easily accommodate this machine, since the tamper unit may be extended beyond the roof and then enclosed. The "Dot" lubricating system is used and so arranged that all greasing may be done at the front of the machine.

Machine No. 1 produces pipe from 3-inch to 18-inch; No. 2, 6-inch to 30-inch; and No. 3, 15-inch to 42-inch. All inside diameters are inclusive. Reinforced pipe may be produced on all machines. Tongue and groove, or culvert, pipe, butt end, and bell and spigot, or sewer, pipe may be produced on any of the machines.

Machines No. 2 and 3 have three speeds of gears, easily and quickly changed, while Machine No. 1 has two speeds of gears. While they do not affect the tamper speeds, they control the speed of the table, so that the tamper strikes a maximum number of blows.

New Tamms Stucco Has White Portland Base

The Tamms Silica Company, Chicago, is introducing on the market a new finish-coat stucco having a white portland cement base. Plasticity and increased strength with a high degree of waterproofness are obtained with an admixture ingredient. Aggregate is comprised of pure white silica sand and genuine white marble.

Established Tamms colors have been used in providing a choice of eight shades.

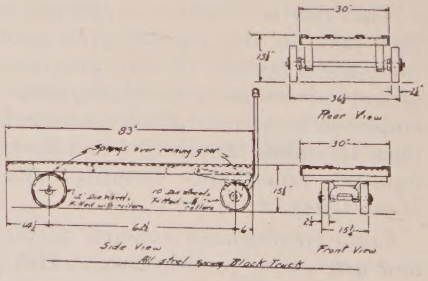
Hand-Rubbed Effect Gained with Sander

The straight-line effect of hand rubbing is secured in a fraction of the time with a "Tiny Turbine" sander which can be easily used in one hand, and in two where additional pressure is desired. A petcock allows the operator to set the tool at any speed up to the maximum and an automatic air brake provides a quick stop.

The Tousley Tool Company, Cleveland, Ohio, is the manufacturer of this sander and similar products.

Chase Foundry Develops Practical Block Truck

The Chase Foundry and Manufacturing Company, Columbus, Ohio, has developed a block truck which eliminates the necessity of transfer cars and lift trucks. It operates on flat-faced truck wheels and each truck is a complete unit. Any convenient truck length may be furnished.


30"
15½"
36½
2¼"
Rear View
83"
Springs over running gear
12" Dia wheels, fitted with rollers
10 Dia wheels, fitted with rollers
15½"
30"
14½
62½
6
2½
15¼
Side View
Front View
All steel spring Block Truck

With the Manufacturers

INDUSTRIAL LITERATURE

Specification Guide

A guide to writing correct specifications for reinforced concrete has been received from the *Concrete Reinforcing Steel Institute*, Chicago, and is entitled *"Standard Specifications Covering Reinforced Concrete to be Incorporated in a General Building Code.*

International Publication

An outline of the history of the *International Portland Cement Company* and a description of its manufacturing processes are a part of the 1927 edition of a booklet published annually describing the International system.

Foreign Steel

A four-page folder on Styrian steels has recently been received from the *Erie Steel Corporation*, New York City, telling of the characteristics and uses of Styrian steel and where it is found. The firm represents the American office of the Schoeller-Bleckmann Steel Corporation, of Vienna, Austria.

Austrian Investigations

Paper No. 11 published by the *Austrian Commission of Concrete and Steel*, of Vienna, discloses conclusions that have been reached as the results of tests on reinforced concrete. These mark the resumption of the first Austrian scientific and experimental work in this direction since 1914.

Lehigh Tests

Data showing test results on high early strength concrete work of varying mixes, some with, and some without, calcium chloride, are included in a folder published by the *Lehigh Portland Cement Company*, Allentown, Pennsylvania.

Pipe Association Folder

One of the recent publications of the American Concrete Pipe Association is a four-page folder entitled *"Concrete Pipe Sewers Installed in 1926,"* showing particularly pipe laid in Chicago and specifying the size and cost per lineal foot and per mile.

How to Use Adensite

How to use *Adensite* in brick, mortar, concrete, cement plaster and floor topping to secure high early strength, is told in a small folder published by the *Adensite Company, Inc.*, New York, N. Y. *Adensite* also has the effect of producing a hard wearing surface.

Ferro-crete Publications

Representatives of the manufacturers of the British quick-hardening cement *"Ferro-crete,"* the *Cement Marketing Company, Ltd.*, Westminster, London, England, have prepared a sixty-four page brochure showing improvements made in England on which *Ferro-crete* was employed.

The *Ferro-crete* bi-monthly bulletin is now being distributed in printed, booklet form.

Crescent Product

Its vertical Crescent tamping foot power brick machine is described by the Raber and Lang Manufacturing Company, Kendallville, Indiana, in a newly issued folder.

Fluresit Tests

The American Fluresit Company, Cincinnati, Ohio, has issued in handy booklet form the summary of laboratory tests showing the favorable results obtained by the use of this admixture.

On Mixers

Two *Jaeger* mixer catalogs, one on tilters, and the other on 10-S non-tilting mixers, have been issued by the *Jaeger Machine Company, Columbus*, Ohio.

Notes from the Field

Rex Representatives

The Chain Belt Company, Milwaukee, Wisconsin, Dallas, Texas, announce the appointment of the *Lone Star Road Machinery Company* as its distributor in the Lone Star State. The company will handle a complete line and will sell all sizes of Rex mixers.

Shepard Buys Hoist Business

The General Electric Co., announces the sale of the entire Sprague Electric Hoist and Winch business to the *Shepard Electric Crane & Hoist Co.*

The Sprague Electric Hoist Division of the *Shepard Electric Crane & Hoist Co.*, New York, N. Y., has been created to handle exclusively the sale of Sprague Hoists and Winches, entirely separate from the sale of Shepard Electric Cranes and Hoists. *Mr. N. A. Hall,* for many years associated with the Sprague Electric works of the General Electric Co., has been appointed manager of this division.

Blaw-Knox in Philadelphia

The Philadelphia office of the *Blaw-Knox Company* has removed from the Colonial Trust Building, to 332 Widener Building.

Quinn Company Begins Production of Traprock

Production of Lake Superior traprock begins May 1st at the Fort William, Ontario, Canada, plant of the *Quinn Stone and Ore Company, Ltd.* The first cargoes are scheduled to be shipped to the *Whitney Materials Company*, Book Building, Detroit, Michigan, who are the Quinn representatives in Detroit territory. Tonnages of various sizes will be carried in stock there.

At a dock at Cleveland, Ohio, certain sizes will be kept in stock, which, with other sizes unloaded from time to time, may be reshipped from Cleveland either by truck or rail. Similar arrangements will be made shortly in other lower lake ports.

This rock is to be available in any size and tonnage, in entire or mixed cargoes. Shipment will also be made from Fort William by rail or truck.

The larger sizes of traprocks are being used for heavy concrete construction work, and the finer sizes for concrete pipe, block and floor topping.

The Quinn Stone and Ore Company is represented by Clement K. Quinn & Co., at Cleveland, Ohio, and at Duluth, Minnesota.

Mixer Musings

Reported by "Joe"—The Mixer Boss.

A Communication from Fellow Slump Tester T. Lain, of Toronto

To the Right Honorable Keeper of the Records:

"I BEG to thank you for the high honor conferred on me, in accepting me in the Guild.

"May I, therefore, as a member make a suggestion?

"Surely Neptune was God of the Sea and not God of the Waters (if I remember my mythology correctly), therefore let us not accept him as our Diety. Salt is harmful to our cause, and he is saltiness itself. Why not have Diana (of the chase), symbolical of chasing away superfluous water (there are few of the fair sex in our business, let us have one), or Narcissus, a river god. Then again there is the hero who defended the bridge at Rome (gosh! I can't think of his name for a minute but any school boy knows of him) who swam the River Tiber and 'e'en the ranks of Tuscany could scarce forbear to cheer.'

"For our catechism, I suggest:

'I believe in Abrams, Discoverer of the Water-
Cement Ratio
And in his Other Findings
They are Good—
Fineness Modulus, Curing and Segregation,
For Good Concrete Is Our Aim
Every Batch to Be the Same.
If Sand and Stone May Slight,
Cement and Water *Must Be Right*."

"T. LAIN, *Certified Slump Tester*."

MANY things have perplexed the Committee on Ways and Means during the past month. Comes a letter from B. F. Affleck, saying that though he had never made a slump test in his long and useful life, he would like to make application provided we had a classification such as "Honorary," or "Superannuated," or "Pensioned," or "Retired," or "Crippled," or something like that. Well, the Committee decided that in view of Mr. Affleck's long and prominent services to the cement industry, he would be duly qualified as an "Honorary" member and so declared him to be.

Then comes a letter of application from Stanton Walker, who needs no introduction to Slump Testers. He applies for membership in the Guild of Certified Slump Testers "only on the understanding, however, that I am accorded all the rights, privileges and immunities thereto appertaining." Don't worry, Stanton—they will be conferred upon you, alright.

The Grand High Truncated Cone has been discovered! Cloyd M. Chapman, C.S.T., is, as far as available records go, the *first* slump tester. In a learned document, published in the *Journal* of the American Concrete Institute for October-November, 1914, on page 429, to be exact, you will find an account of the birth of this epoch-making episode.

Unless some other Slump Tester can present authoritative evidence that he (or she) made a Slump Test before this one, the high honor of Grand High Truncated Cone goes to Mr. Chapman, C.S.T. Some one of these days we will tell more about this FIRST SLUMP TEST.

Joe, the Mixer Boss.

Organizations

American Concrete Institute; Harvey Whipple, Secretary, 2970 West Grand Blvd., Detroit.

American Concrete Pipe Association; M. W. Loving, Secretary, 33 W. Grand Ave., Chicago.

American Construction Council; Dwight L. Hoopingarner, Executive, 28 W. 44th St., New York City.

American Engineering Standards Committee; Dr. P. G. Agnew, Secretary, 29 West Thirty-ninth St., New York City.

American Road Builders' Association; Wm. H. Connell, President, Miss E. A. Birchland, Secretary, 29 W. 39th St., New York City.

American Society for Testing Materials, C. L. Warwick, Secretary-Treasurer, Engineers' Club Building, 1315 Spruce St., Philadelphia, Pa.

Associated General Contractors of America; D. H. Sawyer Secretary, 1150 Munsey Bldg., Washington, D. C.

Associated Metal Lath Manufacturers; 123 West Madison St., Chicago; Wharton Clay, Commissioner.

Building Officials Conference: H. E. Plummer, President, J. F. Downey, City Hall, Cambridge, Mass., Secretary.

Concrete Reinforcing Steel Institute; M. A. Beeman, Secretary, Tribune Tower, Chicago.

Concrete Products Association; S. I. Crew, Cincinnati, Ohio; D. R. Collins, Secretary, 47th and State Streets, Alois Postoffice, Milwaukee, Wis.

Iowa Concrete Products Association; Floyd Goodrich, President; R. L. Gavin, Secretary-Treasurer, 405 Hubbell Bldg., Des Moines, Iowa.

National Association of Building Trades Employers; A. E. Coleman, President; A. W. Dickson, Executive Secretary. 2226 Builders Building, Chicago, Illinois.

National Association of Builders' Exchanges; William F. Chew, Baltimore, President; Earl F. Stokes, Secretary, 15 East Fayette St., Baltimore, Md.

National Crushed Stone Association; J. R. Boyd, Secretary, 751 Earle Building, Washington, D. C.

National Housing Association; Lawrence Veiller, Secretary and Director, 105 East Twenty-second St., New York City.

The National Lime Association: Burton A. Ford, Secretary, 927 15th Street, N. W., Washington, D. C.

National Slag Association; H. J. Love, Secretary-Treasurer, 933 Leader-News Building, Cleveland, Ohio.

National Sand and Gravel Association, V. P. Ahearn, Executive Secretary, 432 Munsey Bldg., Washington, D. C.

Nebraska Concrete Products Association; A. V. Anderson, President, Reimers-Kaufman Co., Lincoln, Neb.; E. L. Bateman, Secretary, Bethany, Neb.

Ohio Concrete Products Association; G. M. Friel, Secretary-Treasurer, 2284 North High St., Columbus, Ohio.

Portland Cement Association; William M. Kinney, General Manager, 33 West Grand Ave., Chicago.

Rail Steel Bar Association; H. P. Bigler, Engineering Secretary, 111 W. Jackson Blvd., Chicago, Ill.

Wisconsin Concrete Products Association; A. P. Kuranz. Secretary-Treasurer, 425 E. Water St., Milwaukee.